

**ALABAMA DEPARTMENT
OF AGRICULTURE AND INDUSTRIES
PESTICIDE MANAGEMENT**

**COMMERCIAL
PESTICIDE APPLICATOR
STUDY MANUAL FOR**

RECERTIFICATION EXAM

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Foreword

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As of October 21, 1977, anyone wishing to use "restricted use" pesticides must be certified. Certification is a way of ensuring that applicators know the safe and correct way to handle and apply pesticides. Applicators may be certified as private and/or commercial applicators.

This self-study manual is designed to help people wishing to become certified as commercial pesticide applicators in Alabama. Commercial applicators are defined as applicators who use or supervise the use of any "restricted use" pesticide on properties other than their own for hire.

The Environmental Protection Agency (EPA) has set minimum competency standards for pesticide applicators. These minimum standards include a practical knowledge of such subject areas as pest identification, pest control, label comprehension, pesticide laws, and environmental considerations. The actual certification of applicators is the responsibility of each individual state.

In Alabama, the Department of Agriculture and Industries is the agency responsible for certification of pesticide applicators. The Department issues certified applicators a permit which is necessary in order to purchase or apply "restricted use" pesticides in Alabama. There are seventeen categories of commercial pesticide applicators in Alabama. A specific category is determined by the type of work done by the applicator and the method of application. These commercial applicator categories are defined below. Commercial applicators are licensed only for the category or categories for which they have proven to be competent.

Competency is determined on the basis of a written examination. This examination includes the general standards applicable to all categories and the additional standards specific for each category. Page 2 lists the examination requirements for each commercial category.

Once a commercial applicator becomes certified in Alabama, certification is maintained by a point system. This point system is described on page 3. Alabama has reciprocity agreements with Mississippi and Georgia with regard to most commercial categories. Contact the Department of Agriculture and Industries to determine if certification in your category is transferable to or from one of these states.

Pesticides may be federally restricted by EPA, or they may be restricted for use in Alabama by the Department of Agriculture and Industries. Generally, pesticides are restricted because they may be especially harmful to the applicator, other people, or the environment unless they are applied by competent individuals. The list of "restricted use" pesticides changes periodically. See your county Extension agent for a current list.

Categorization Of Commercial Pesticide Applicators In Alabama

There are seventeen (17) categories of Commercial Pesticide Applicators in Alabama. A specific category is determined by the type of work done by the applicator and the method of application. All categories relate to the use of Restricted Pesticides.

Applicator Categories

1. AGRICULTURAL PLANT: AERIAL APPLICATOR—Applicators in this category apply pesticides to agricultural crops using aerial equipment.

2. AGRICULTURAL PLANT: GROUND APPLICATOR—Applicators in this category apply pesticides to agricultural crops using ground equipment.

3. RIGHT-OF-WAY PEST CONTROL—This category includes maintenance or pest control of public roads, on electric power lines, pipelines, railway right-of-ways, or other similar areas.

4. FOREST PEST CONTROL—Applicators in this category apply pesticides in forests, forest nurseries, and forest seed-producing areas.

5. PUBLIC HEALTH PEST CONTROL—This category includes county, state, federal, or other governmental employees using pesticides in public health programs for the management and control of pests having medical or public health importance, including aquatic areas.

6. AQUATIC PEST CONTROL—This category includes pesticide application to standing or running water, other than public health purposes.

7. SEED TREATMENT—This category includes the use of pesticides on seeds of all types.

8. DEMONSTRATION AND RESEARCH PEST CONTROL—Applicators in this category include persons who demonstrate the use of pesticides or supervise their use and persons conducting field research. Included in this group are Extension agents and specialists, commercial representatives, and state, federal, and commercial personnel conducting research.

9. ORNAMENTAL AND TURF PEST CONTROL (COMMERCIAL)—This category includes pest control in maintenance and production of ornamental trees, shrubs, flowers, and turf on a fee basis.

10. ORNAMENTAL AND TURF PEST CONTROL (CUSTODIAL)—Applicators in this category apply pesticides to ornamentals and turf as a responsibility to an employer. Examples of custodial applicators are golf course superintendents, park maintenance personnel and supervisors, cemetery maintenance personnel, custodians of other public areas. They are limited to a specific area and cannot charge a fee.

11. **INDUSTRIAL, INSTITUTIONAL, STRUCTURAL, AND HEALTH RELATED PEST CONTROL**—There are four major classifications of applicators under this category. The sub-categories are based on the specific type of work done.

a. *Household, Institutional, and Industrial Pest Control (Commercial)*—Applicators in this category apply pesticides in or around food-handling establishments, human dwellings, institutions and schools, hospitals, and industrial establishments, including warehouses, grain elevators, etc. This work is done commercially for a fee.

b. *Household, Institutional, and Industrial Pest Control (Custodial)*—Applicators in this category apply pesticides as a part of their responsibilities to an employer such as a school, industry, warehouse, etc. They are limited to a specific area (building) and cannot charge a fee.

c. *Control and/or Eradication of Wood-Destroying Organisms (Insects & Fungi)*—Applicators in this category

apply pesticides for control of termites, wood borers, fungi, and other wood destroying organisms within or under structures.

d. *Fumigation Pest Control*—Applicators in this category apply fumigants to one or more rooms or to an entire structure to eradicate pests such as insects and rodents.

e. *Wood Preservation*—Applicators in this category treat wood products to prevent decay.

12. **REGULATORY PEST CONTROL**—This category includes state, federal, or other governmental employees who use or supervise the use of pesticides in the control of regulated pests.

13. **TBT ANTIFOULING PAINTS**—Applicators in this category apply antifouling paints containing tributyltin (TBT) for the control of marine fouling organisms.

Examination Requirements For Commercial Pesticide Applicator Categories In Alabama

Applicator Category	Examination Requirements
Agricultural Plant: Aerial	General Standards Agricultural Plant Aerial Applicator
Agricultural Plant: Ground	General Standards Agricultural Plant Ground Standards
Right-of-Way Pest Control*	General Standards Right-of-Way
Forest Pest Control (Aerial)	General Standards Forest Aerial Applicator
Forest Pest Control..... (Tree injector only)	General Standards Forest
Public Health Pest Control*	General Standards Public Health
Aquatic Pest Control*	General Standards Aquatic Pest Control
Seed Treatment Pest Control.....	General Standards Seed Treatment
Demonstration and Research Pest Control	General Standards Demonstration and Research
Ornamental and Turf Pest Control..... (Commercial and Custodial)	Ornamental and Turf
Industrial, Institutional, Household	Industrial, Institutional, and Household (Commercial)
Pest Control (Commercial)	
Industrial, Institutional, Household	Industrial, Institutional, and Household (Custodial)
Pest Control (Custodial)	
Industrial, Institutional, Household	Control and/or Eradication of Wood Destroying Organisms, Insects, and Fungi
Control of Wood-Destroying Organisms, Insects, and Fungi	
Industrial, Institutional, Household	Fumigation Pest Control
Fumigation Pest Control	
Regulatory Pest Control	Regulatory Pest Control
TBT Antifouling Paints	Tributyltin Antifouling Paints
Wood Preservation	Wood Preservation

*Aerial applicators must also take the Aerial Applicator Test.

Renewal Of Restricted Use Pesticide Permits

I. Commercial Pesticide Applicator permits shall be renewable 3 years from date of issue.

Renewal shall be based on a point system in which the

permit holder must accumulate a total of 50 points in the 3-year period according to the schedule below.

II. For permit renewal purposes, the Commissioner shall subtract up to 15 points per year for proven negligent pesticide application.

Applicator Permit Renewal Point System

A. Proven attendance at a training session approved by the Commissioner10 points

B. Accomplishment of reexamination:

Pass examination in permit category(ies) desired50 points

C. Other:

A calendar year free of pesticide-related incidents that require investigation
of a federal, state, or other governmental agency10 points

Chapter 1

Pests

Objectives

After completing this unit, the trainee will:

- Identify the five main groups of pests and the specific pests associated with each group.
- Name the physical characteristics which aid in the identification of specific insects.
- Identify the main cause of plant diseases.
- Differentiate between the life cycles of annuals, biennials, and perennials.
- Classify plants as annuals, biennials, or perennials.
- Describe the developmental stages through which plants progress.

Introduction

The first step in solving any problem is to determine its cause. So the first step in your job is to recognize the pests you need to control.

Living things that compete with us for food, fiber, and space, or attack us directly are *pests*. The living plant or animal some pests depend on for survival is called the host.

There are five main groups of pests:

1. Insects (plus mites, ticks, and spiders).
2. Snails and slugs.
3. Vertebrates.
4. Plant disease agents.
5. Weeds.

Applicators should know most of the pests they see on the job. When unfamiliar pests appear, you should get identification aids, publications, and pictures to help find out what they are or contact local experts, such as county Extension agents, land-grant or other universities, pesticide dealers or representatives, and vocational agriculture instructors.

Insects

Insects thrive in more environments than any other group of animals. They live not only on the earth's surface but in the soil and water. They are in deserts, rain forests, hot springs, snow fields, and dark caves. They eat the choicest foods from the table of human beings and can even eat the table.

Many types of insects affect crops by causing damage in a variety of ways. They may:

- Feed on leaves.
- Tunnel or bore in stems, stalks, and branches.
- Feed on and tunnel in roots.
- Feed on or in seeds and nuts.

- Suck the sap from leaves, stems, roots, fruits, and flowers.

- Carry plant disease agents.

The plants are damaged, weakened, or killed. This causes reduced yields, lowered quality, and ugly plants or plant products that cannot be sold. Even after harvest, insects continue their damage in the stored or processed products. Insects also feed on and in human beings and other animals. Some of these pests carry disease agents which have caused millions of deaths to human beings and livestock.

Not all insects are pests. Some help human beings by pollinating plants or feeding on other insects that are pests. Other insects are neither beneficial nor harmful to human beings, but are an important part of food chains.

Recognizing

Common Features Of Insects

All adult insects have two things in common: six jointed legs and three body regions. But to tell one insect from another, the most important parts to look at are *wings* and *mouthparts*. Some insects have no wings, and others have two or four. The wings vary in shape, size, thickness, and structure. Some insects have chewing mouthparts with toothed jaws that bite and tear their food. Other insects have piercing-sucking mouthparts which they force into a plant or animal to suck out blood or other fluids.

Almost all insects change in shape, form, and size during their life cycle. This change is called *metamorphosis*.

Some insects change only in size as they develop. The adults lay eggs. A *nymph* which looks like a tiny adult hatches from the egg and goes through several stages. These nymphs change into wingless adults. Usually, the nymphs and adults have similar mouthparts and eat the same types of food. An example of this kind of insect is the bristletail.

Some insects change form slightly. Their nymphs hatch from eggs. These nymphs, which have no wings, go through several growing stages before changing into winged adults. Examples are: chewing lice, sucking lice, thrips, termites, grasshoppers, crickets, cockroaches, true bugs, aphids, leafhoppers, spittlebugs, and scale insects.

Other insects change completely. They go through four stages. The *egg* hatches into a *larva*. The larva is a worm, caterpillar, grub, or maggot. This is the stage in which these insects grow the most and do the most damage. When full grown, the larva changes into a *pupa*. During this stage it changes into the *adult*. The adult stage usually has wings. The larvae and adults may have completely different

mouthparts and may eat food from entirely different sources, or they may have similar mouthparts and eat the same types of food. Examples of insects in this category are: moths, butterflies, beetles, flies, mosquitoes, bees, wasps, ants, and sawflies.

Bristletails

No wings.
Chewing mouthparts.
Usually have two or three long tails.
Young and adult look alike (no change in form).
Usually found in houses and other buildings.
Feed on plant fiber, cloth, and all starches.
Silverfish and firebrats belong to this group.

Chewing Lice

No wings.
Chewing mouthparts.
Broad head.
Young and adult look alike.
Usually found on birds. They cause skin irritation and reduced weight gain and egg production.

Sucking Lice

No wings.
Piercing-sucking mouthparts.
Narrow head.
Young and adults look alike.
Some feed on livestock.
Some carry disease agents.
Their bite may be painful and cause itching.
Human body, head, and pubic (crab) lice belong in this group.

Thrips

Some have fringed wings; others have no wings.
Combination of chewing (rasping) and sucking mouthparts.
Young and adults look alike.
Usually found in flowers or buds of plants.
May cause misshapen or poorly developed flowers, buds, fruits, and leaves.

Termites

Swarming termites have four wings of equal size and shape; others are white and have no wings.
Chewing mouthparts.
Young and adults look alike.
Usually feed on wood products such as fence posts, timbers, and flooring.
Damage to the wood in homes and other structures is common.

Grasshoppers, Crickets, And Cockroaches

Some have wings; others do not have fully developed wings.
Top pair of wings is leathery.
Chewing mouthparts.
Young and adults look alike, but young lack wings.
Grasshoppers usually feed on plant leaves and stems.

Crickets are found in the field or indoors. They eat almost anything made from plants.

Cockroaches often occur in restaurants, houses, stores, and offices. They eat the same foods human beings do.

True Bugs And Related Insects

Some have wings; some do not. Top pair of wings is partly leathery and partly transparent.

Piercing-sucking mouthparts.

Young of aphids, leafhoppers, and spittlebugs look like the adults.

Adult scale insects are scale-covered and stay in one place on the plant.

Suck the juices from plants.

Reduce the vitality and yield of plants.

Some carry plant disease agents.

Moths And Butterflies

Most adults have four large wings with many scales that rub off easily.

Most moths are a dull brown color; butterflies are brightly colored.

Mouthparts of some adults are lacking or are a coiled tube used for sucking.

Larvae are caterpillars, usually with six jointed legs and ten soft, fleshy legs.

Larval stages are important pests on many crops. They damage leaves, stems, tubers, fruit, and cloth.

Clothes moths are in this group.

Beetles

Adults' top two wings are usually hard and shiny and bottom wings are transparent.

Chewing mouthparts.

Young are grubs or worms. Some have no legs; others have six.

Both the adult and larval stages may damage stored food products, plants, and, in some cases, animals and animal products.

Flies And Mosquitoes

Adults have only two wings (other winged insects have four).

Mouthparts of adults are piercing-sucking, but may be slightly modified for sponging, rasping, or cutting.

Young (except mosquitoes) are maggots.

Head of young is usually not well-defined; mouthparts are small, dark, and hook-like.

Young mosquitoes live in water. They have well-developed heads with chewing mouthparts.

Maggots usually feed on plant seedlings and roots, in organic matter, in water, and in other damp places.

Some maggots feed on animals.

Some adults carry disease agents.

Some flies or mosquitoes in large numbers reduce the production efficiency of animals.

Bees, Wasps, Ants, And Sawflies

Most adults have a narrow waist; sawflies are an exception.

Some have four wings; others have none.

Chewing mouthparts.

Most young are worm-like with no legs. The young of sawflies are caterpillar-like.

Young usually in nests in soil or made of mud, paper, or wax.

Painful sting of many adults makes some of these pests.

Others may damage wood products.

Recognizing Other Related Arthropods

Mites, ticks, and spiders are closely related to insects.

The main differences are that the adults:

- Have eight jointed legs instead of six.
- Have two body regions.
- Do not have wings.

Mites

Adults and nymphs have eight legs; larvae have six.

Very small—about the size of the period at the end of this line.

No wings.

Sucking mouthparts.

Soft-bodied.

Injury they cause is usually noticed before the mites are found.

When they are present on plants in large numbers, their feeding turns foliage and buds whitish, reddish, or brown.

Some mites may scar fruit.

Some mites make thin webs on plants.

On animals, they cause severe skin irritation, redness, scabs, and scaliness.

Chiggers (also called jiggers and red bugs) that attack human beings are mites.

Ticks

Adults and nymphs have eight legs; larvae have six.

Leathery or soft (sometimes colored) body without a distinct head.

Piercing-sucking mouthparts with which they firmly attach themselves to the host animal.

Parasitic on animals, including humans.

Must have blood to complete their life cycle.

Some carry disease agents to humans and animals.

Spiders

Eight legs.

Biting mouthparts.

Vary in length from a fraction of an inch to 5 or 6 inches.

Useful to human beings because they eat insects, but webs and excretions may be a nuisance.

Black widow and brown recluse bites are dangerous to human beings.

Snails And Slugs

Snails and slugs are members of a large group of animals called mollusks. Snails have a hard shell; slugs have

no shell. They feed on plant foliage. They are pests in lawns, landscape plantings, and greenhouses.

Vertebrates

All vertebrate animals have a jointed backbone. Vertebrates include fish, snakes, turtles, alligators, lizards, frogs, toads, salamanders, birds, and mammals (including rodents). What may be a pest animal in some situations may be highly desirable in others. A muskrat, for instance, is a fur-bearing animal, but its burrows may weaken earthen dams.

Fish

Human beings have caused most fish problems. We have put some kinds where they normally would not have been. Some fish are undesirable because they are not useful for sport or for food. Others compete with more desirable species. Some fish are intermediate hosts for parasites of humans.

Reptiles And Amphibians

Reptiles (snakes, lizards, turtles, and alligators) and amphibians (frogs, toads, and salamanders) may cause local problems. Although most of them do little damage, many people fear or dislike them. Poisonous snakes can be a real problem. Snakes and turtles in fish hatcheries or waterfowl production areas are problems, too.

Birds

Bird damage can be quite varied. It includes: (1) structural damage by woodpeckers, (2) destruction of feed, fruit, nut, grain, timber, and vegetable crops by seed- and fruit-eating birds, (3) hazards to animal and human health caused by birds like pigeons and parakeets, and (4) annoyance caused by birds roosting near dwellings. Peck marks, tracks, feathers, and droppings are signs of bird damage.

Mammals

Damage by mammals is varied. Some cause serious health problems to livestock and humans. Disease agents that mammals transmit to human beings cause rabies, plague, food poisoning, and tularemia. Killing of other animals by mammals is costly. Some damage fruit, vegetable, nut, grain, range, and tree crops. The damage they do to dams and ditches can be very costly. They damage such things as lawns, clothing, furniture, and buildings by gnawing and burrowing. Mice and rats annoy by living in our homes, offices, and factories.

How do you tell what mammal caused the damage? You can eliminate some suspects if you know which animals are found in your part of the country, what kinds of places they live in, and what their habits are. Animal signs (tracks, droppings, toothmarks, diggings, burrows, hair, and scent) plus the type of damage will give you further clues.

Plant Diseases

A plant disease is any harmful condition that makes a plant different from a normal plant in its function or ap-

pearance. Both living organisms and nonliving agents often cause diseases or other undesirable effects on plants.

Nonliving Agents (Nonparasitic Plant Diseases)

Nonliving agents include nutrient deficiencies, extreme cold or heat (frost, fire), toxic chemicals (air pollutants, some pesticides or their misapplication, salts, too much fertilizer), mechanical injury (wind), and too little or too much water. These "diseases" cannot be passed from one plant to another. Disorders caused by nonliving agents often resemble the symptoms of injury caused by living organisms. For example, certain types of chemical injury can look like some of the leaf-spots caused by fungi or bacteria.

Living Organisms (Parasitic Plant Diseases)

Three things are required before a parasitic disease can develop:

1. A susceptible host plant.
2. A parasitic agent.
3. An environment favorable for parasite development.

Some diseases are caused by living organisms which live and feed on or in plants. These organisms can be passed from one plant to another. These living organisms include fungi, bacteria, viruses, and nematodes.

Fungi

Fungi are plants that lack chlorophyll and cannot produce their own food. Most fungi reproduce by spores, which function about the same way seeds do. Fungi may attack a plant both above and below the soil surface. Fungus diseases include apple scab, anthracnose of beans, smut in corn, and powdery mildew on landscape plantings.

Bacteria

Bacteria are microscopic one-celled plants. They reproduce by simply dividing in half or by spore production. Bacteria can build up fast under ideal conditions. Some can divide every 30 minutes. Fire blight of pears, halo blight of beans, and bacterial leaf spot on peaches are caused by bacteria.

Viruses

Viruses are so small that they cannot be seen with an ordinary microscope. They are generally recognized by their effect on plants. Many viruses that cause disease are carried by insects, usually aphids or leafhoppers. Viruses are also easily carried along in bulbs, roots, cuttings, and seeds. Some viruses are transmitted when machines or men touch healthy plants after touching diseased plants. A few are transmitted in pollen and nematodes. At least one virus is transmitted by a fungus. Wheat streak mosaic, tobacco mosaic, and corn dwarf are diseases caused by viruses.

Nematodes

Nematodes are small, sometimes microscopic, roundworms. They are also called eelworms. Many nematodes are harmless. Others may attack crops planted for food, fiber, or landscape purposes and feed on or in the roots.

Some species attack plant parts above the ground, such as leaves, stems, and seeds. Nematodes usually do not kill plants, but reduce growth and plant health. They weaken the plant and make it susceptible to other disease agents.

All nematodes that are parasites on plants have a hollow feeding spear. They use it to puncture plant cells and feed on the cell contents. Nematodes may develop and feed either inside or outside a plant. Their life cycle includes an egg, four larval stages, and an adult. Most larvae look like adults but are smaller. The females of some, such as root-knot and cyst nematodes, become fixed in the plant tissue. Their bodies become swollen and rounded. The root-knot nematode deposits its eggs in a mass outside of its body. The cyst nematode keeps some of its eggs inside its body after death. The eggs may survive there for many years.

Development Of Plant Diseases

Temperature and moisture are especially important factors in disease caused by living organisms. They affect the activity of the organism, the ease with which a plant becomes diseased, and the way the disease develops.

The disease process starts when the organism arrives at a part of a plant where infection can occur. This step is called *inoculation*. If environmental conditions are favorable, the organism will begin to develop. This stage before injury develops is called *incubation*. If the organism can get into the plant, the stage called *infection* starts. The plant is diseased when it responds to the organism. The three main ways a plant responds are:

- Overdevelopment of tissue, such as galls, swellings, and leaf curls.
- Underdevelopment of tissue, such as stunting, lack of chlorophyll, and incomplete development of organs.
- Death of tissue, such as blights, leaf spots, wilting, and cankers.

Identifying Plant Diseases

You cannot always tell one plant disease from another just by looking at the plant itself. Because many disease agents cause similar injury, you need other evidence. Identifying the cause is a better way of identifying the disease. You usually need a microscope or magnifying lens to see such things as fungus spores, nematodes or their eggs, and bacteria.

Weeds

Plants are considered weeds when they interfere with human activities or welfare. Weeds are simply plants growing where they are not wanted or in a way that is not desirable. Weeds reduce crop yields, increase costs of production, and reduce the quality of crop and livestock products, and some cause skin irritation and hay fever. Some weeds are poisonous to human beings and animals, and they spoil the beauty of turf and landscape plants.

Classifications

Most pest plants are either (1) grasses or (2) broadleaves. The sedges, such as the nutsedges, are not classified as ei-

ther grasses or broadleaves. However, they have similar characteristics to grasses and are often listed under grasses on the pesticide label. Grasses, sedges, and broadleaves contain species with annual, biennial, and perennial life cycles. All plants go through several developmental stages. Knowledge of all these characteristics is necessary for a successful weed control program.

Grasses

Grass seedlings have only one leaf as they emerge from the seed. Their leaves are generally narrow and upright with parallel veins. Most grasses have fibrous root systems. The growing point on seedling grasses is sheathed and located below the soil surface. The growing point gradually moves above the soil as the plant grows and matures. Examples of weed species are crabgrass, Johnsongrass, bermudagrass, and annual bluegrass.

Broadleaves (Forbs)

Herbaceous (plants that do not develop persistent woody tissue above ground) broadleaf seedlings have two seed leaves as they emerge from the seed. Their true leaves are generally broad with net-like veins. Broadleaves usually have a taproot and a relatively coarse root system. All actively growing broadleaf plants have exposed growing points at the end of each stem and in each leaf axil. Perennial broadleaved plants may also have growing points on roots and stems below the surface of the soil. Examples of broadleaf weed species include pigweed, mullein, dandelion, plantain, henbit, and spurge.

Woody Plants

Woody plants are those that form wood. They include:

BRUSH AND SHRUBS—Woody plants that have several stems and are less than 10 feet tall. When trees are present, brush or shrubs may be called understory.

TREES—Woody plants that usually have a single stem (trunk) and are over 10 feet tall.

Developmental Stages

All plants have four stages of development:

1. **SEEDLING**—Small and vulnerable. Seed leaves still present or seed leaves lost and true leaves present.
2. **VEGETATIVE**—Rapid growth of stems, roots, and foliage. Uptake of water and nutrients is rapid.
3. **REPRODUCTIVE**—Little or no growth; production of flowers and fruit. Uptake and movement of water and nutrients slow and directed mainly to reproductive parts—flowers, fruits, and seeds.
4. **MATURITY**—Little or no growth. Movement of water and nutrients in plant is slow.

Plant Life Cycles

A plant's life cycle is either annual, biennial, or perennial.

Annuals

Annuals complete all four stages of development in less than 12 months. There are two distinct kinds of annuals—winter annuals and summer annuals.

Winter annuals germinate in the fall, overwinter, mature, set seed, and die in the spring. For best results, control winter annuals at or soon after germination in the fall. Examples of winter annuals are cheat, chickweed, henbit, little barley, annual bluegrass, and wild mustard.

Summer annuals germinate in the spring, grow, set seed, and die in the fall. For best results, control summer annuals at or soon after germination in the seedling stage of growth. Examples of summer annuals are common ragweed, crabgrass, partridge pea, pigweed, and spotted spurge.

Some weeds are specifically winter or summer annuals. Other species can germinate and grow in either the fall or the spring. Knowing the growth habits of annuals is important in planning how and when to control them.

Biennials

Biennials complete their life cycle in two years. Biennial plants complete the seedling and vegetative stages of growth in the first year and the seed production and maturity stages in the second year. Biennial weeds are most easily controlled in their first year of growth. Some herbicide product labels identify biennials as annuals. Examples of biennials are musk thistle, common mullein, wild carrot, and false dandelion.

Perennials

Perennials may complete all four stages in the first year and then repeat the vegetative, seed production, and maturity stages for several following years, or the seed production and maturity stages may be delayed for several years. Some perennial plants die back in the maturity stage each winter; others, such as trees, may lose their leaves but do not die back to the ground. They all reproduce by seed, but many are able to spread and reproduce vegetatively. Perennials are difficult to control because of their persistent root system. For best results, control perennials in the seedling stage or the reproductive stage.

Perennials are divided into three general groups, depending upon how they reproduce—simple, creeping, and bulbous.

Simple perennials spread by seed, crown buds, and cut root segments. Most have a large, fleshy taproot. Examples of some common simple perennials are curly dock, dandelion, plantain, spiderwort, and white heath aster.

Creeping perennials spread vegetatively with stolons or rhizomes as well as by seed. Examples of common creeping perennials are bermudagrass, big bluestem, common milkweed, horsenettle, horsetail, Johnsongrass, poison ivy, and Virginia creeper.

Bulbous perennials reproduce vegetatively from underground bulbs or tubers. They also produce seed. Examples are wild garlic, yellow nutsedge, and Star-of-Bethlehem.

Brush, shrubs, and trees may spread vegetatively through sucker shoots as well as by seed. Woody plants can best be controlled just before flowering.

Chapter 1

Test

1. Define the terms *pest* and *host*.

Pest _____

Host _____

2. List five main groups of pests.

- a. _____
- b. _____
- c. _____
- d. _____
- e. _____

3. Name two identifying characteristics common to all adult insects.

- a. _____
- b. _____

4. Name two characteristics which aid in distinguishing one insect from another.

- a. _____
- b. _____

5. Explain the differences between the basic life cycles of insects.

6. Name three identifying characteristics of mites, ticks, and spiders.

- a. _____
- b. _____
- c. _____

7. List four types of vertebrate animals that can be pests.

- a. _____
- b. _____
- c. _____
- d. _____

8. List types of living organisms that cause plant diseases.

- a. _____
- b. _____
- c. _____
- d. _____

9. List three main ways a plant responds to infection by a plant disease agent.

- a. _____
- b. _____
- c. _____

10. Define weeds.

11. State the characteristics of herbaceous grasses, herbaceous broadleaf plants, and woody plants.

Grasses

Broadleaf plants

Woody plants

_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

12. Explain the developmental stages of plants.

13. Explain the difference in life cycle for annuals, biennials, and perennials

- a. Annuals _____
- b. Biennials _____
- c. Perennials _____

14. Classify the following plants as annuals (A), biennials (B), or perennials (P) by placing an A, B, or P in front of each plant name.

- ___ a. pigweed
- ___ b. mullein
- ___ c. henbit
- ___ d. Johnsongrass
- ___ e. curly dock

Chapter 2

Pest Control And Pesticides

Objectives

After completing this unit, the trainee will:

- Match terms associated with pesticides to the correct function they perform.
- Describe the ways in which pesticides effectively attack the target pest.
- Identify the best method of control associated with a specific pest.
- Understand the considerations involved in choosing the formulation that will best meet the requirements for a particular job.
- Know the abbreviated descriptions of the types of formulations available.
- Understand the advantages and disadvantages of each formulation.
- Match the methods of pesticide application to the correct description.

Principles Of Pest Control

To solve pest problems, you must:

1. Identify the pest.
2. Know what control methods are available.
3. Evaluate the benefits and risks of each method or combination of methods.
4. Choose the methods that are most effective and the least harmful to yourself and the environment.
5. Know the correct use of the methods.
6. Know local, state, and federal regulations that apply to the situation.

The most important principle of pest control is to use a pest control method only when that method will prevent the pest from causing more damage than is reasonable to accept. Even though a pest is present, it may not be necessary to use a pesticide. It could cost more to control the pest than would have been lost because of the pest's presence.

Pest control involves using all available methods to keep the pests below harmful levels, while damaging the environment as little as possible in the process. The challenge lies in the ability to control pests so that damage caused by them is held to a minimum and to recognize when direct action, such as a pesticide application, is necessary.

Pest Control Methods

Many pest control methods have been known and used for years. Here are the most important.

Resistant Varieties

Pest control by use of resistant varieties is common to agriculture. Some crops, animals, and woods resist or are immune to certain pests.

Biological Control

Biological control is most common for insects, mites, and some weeds. Biological control occurs naturally. Releasing more of a pest's natural enemies—parasites, predators, and disease agents—into the target area can increase this natural control.

Cultural Control

Cultural practices used in crop production can sometimes be used to control pests. These practices include planting patterns, tillage practices, crop rotation, fertilization, irrigation, and others.

Physical Control

Some physical control methods and examples of their use include fire to control weeds; traps for rats, mice, and birds; light to attract or repel pests; sound to kill, attract, or repel pests; heat or cold to kill insects and disease organisms; radiation to sterilize or kill pests; and electrocution to kill pests.

Sanitation

Sanitation is removing the source of food or filth on which pests feed.

Legal Control

Legal controls result from federal, state, or local laws and regulations. They include such things as quarantines, inspections, embargoes, and compulsory crop or product destruction.

Pesticides

Pesticides often must be used to prevent harmful pest levels. Use pesticides where they are needed and where they can be used safely. Select and use pesticides to complement other pest control methods.

Using pesticides along with other methods is often better than using any one method by itself. The methods chosen will depend on the kind and amount of control needed.

The three main pest control strategies are:

1. PREVENTION—Keeping a pest from becoming a problem.
2. SUPPRESSION—Reducing the pest numbers or damage

to an acceptable level or preventing growth to an excessive size.

3. **ERADICATION**—Destroying or removing a pest completely from a geographic region.

Pesticides

Pesticides are chemicals used to destroy, prevent, or control pests. They include chemicals used to attract or repel pests and chemicals used to regulate plant growth or to remove leaves.

The following are the types and uses of pesticides:

INSECTICIDE—Kills insects.

MITICIDE—Kills mites.

ACARICIDE—Kills mites, ticks, and spiders.

NEMATOCIDE—Kills nematodes.

FUNGICIDE—Kills fungi.

BACTERICIDE—Kills bacteria.

HERBICIDE—Kills weeds.

RODENTICIDE—Kills rodents.

AVICIDE—Kills birds.

PISCICIDE—Kills fish.

MOLLUSCICIDE—Kills mollusks, such as slugs and snails.

PREDACIDE—Kills vertebrate pests.

REPELLENT—Keeps pests away.

ATTRACTANT—Lures pests.

PLANT GROWTH REGULATOR—Stops, speeds up, or otherwise changes normal plant processes.

DEFOLIANT—Removes unwanted plant growth without killing the whole plant immediately.

DESICCANT—Dries up plant leaves and stems and insects.

ANTITRANSPIRANT—Reduces loss of water from plant tissues.

The Nature Of Pesticides

Pesticides can be grouped according to their chemical nature. The groups are:

INORGANIC PESTICIDES—These are made from minerals. Minerals used most often are arsenic, boron, copper, lead, mercury, sulfur, tin, and zinc. Example: Lead arsenate.

SYNTHETIC ORGANIC PESTICIDES—These are man-made pesticides. They contain carbon, hydrogen, and one or more other elements such as chlorine, phosphorus, and nitrogen. Examples: 2,4-D, atrazine, captan, malathion, and parathion.

LIVING MICRO-ORGANISMS—These are viruses, bacteria, and fungi produced by man. Examples: the bacterium *Bacillus thuringiensis* and the polyhedrosis virus.

PLANT-DERIVED ORGANIC PESTICIDES—These are made from plants or plant parts. Examples: nicotine, pyrethrins, red squill, rotenone, and strychnine.

How Pesticides Work

Pesticides also can be grouped according to what they do. Many synthetic organic pesticides work in more than one way. Read the label to find out what each pesticide will do.

The major groups are:

PROTECTANTS—Applied to plants, animals, structures, and products to prevent entry or damage by a pest.

STERILANTS—Make pests unable to reproduce.

CONTACTS—Kill pests simply by contacting them.

STOMACH POISONS—Kill pests when swallowed.

SYSTEMICS—Taken into the blood of an animal or sap of a plant. They kill the pest without harming the host.

TRANSLOCATED HERBICIDES—Kill plants by being absorbed by leaves, stems, or roots and moving throughout the plant.

FUMIGANTS—Gases which kill when they are inhaled or otherwise absorbed by the pest.

ANTICOAGULANTS—Prevent normal clotting of blood.

SELECTIVE—More toxic to some kinds of plants or animals than to others.

NONSELECTIVE—Toxic to most plants or animals.

PHEROMONES—Affect insects by changing their behavior.

Plant Growth Regulators, Desiccants, Defoliants, And Antitranspirants

PLANT GROWTH REGULATORS—All plant parts are made up of tiny cells which continually multiply and grow. Plant growth regulators speed up, slow down, or otherwise affect cell growth and reproduction. They are used to decrease preharvest drop, increase fruit firmness, reduce scald, increase color, thin fruit, increase flowering, reduce fruit cracking, promote uniform bearing of fruit, control plant height, prevent or delay sprouting of tubers, promote or inhibit growth, promote earlier flowering, prevent seed formation, induce branching, reduce suckering, hasten fruit maturity, and increase seed yield.

DESICCANTS AND DEFOLIANTS—These often are called harvest-aid chemicals because they help the farmer harvest his crop. Both are used to get rid of leaves, stems, and weeds in such crops as cotton, soybeans, and potatoes.

ANTITRANSPIRANTS—By reducing water loss, they can prevent winter damage, maintain color in evergreens, protect against salt damage, help protect transplants, and prevent needle drop on Christmas trees.

Pesticide Resistance

The ability of pests to resist poisoning is called pesticide resistance. Consider this when planning pest control programs that rely on the use of pesticides.

Rarely does any pesticide kill all the target pests. Each time a pesticide is used, it selectively kills the most sensitive pests. Some pests avoid the pesticide. Others are able to withstand its effects. Pests that are not destroyed pass along to their offspring the trait that allowed them to survive.

When we use one pesticide repeatedly in the same place, the pest population sometimes builds up its resistance. Some pests have become practically immune to poisoning by certain pesticides.

Not every pesticide failure is caused by pest resistance, however. Make sure that you have used the correct pesticide, used the correct dosage, and applied the pesticide correctly.

Using Pesticides

Many terms describe when and how to use pesticides. These terms are used in labeling. They also are found in leaflets and bulletins that you may get from your county Extension agent or others at a land-grant university.

The rate and time of application of pesticides are critical. Most pesticides work at very low rates. If you use too much, they can harm or even kill the plant or animal you wish to protect. Pesticides work best when applied at specific times. Applying them before or after the correct time reduces or even eliminates their effectiveness.

Since all these chemicals work in small amounts, be careful to treat only the intended target. Avoid getting them on anything else as a result of drift or of residue in application equipment or soil.

When To Use

Terms that tell you *when* to use the pesticide include:

PREEMERGENCE—Used before crop or weeds emerge. May also refer to use after crops emerge or are established, but before weeds emerge.

PREPLANT—Used before the crop is planted.

POSTEMERGENCE—Used after the crop or weeds have emerged.

How To Use

Pesticide applicators use many methods to apply pesticides. Proper techniques of application not only aid in effectiveness but also ensure the safety of workers and protection of the public and the environment.

Terms that tell you *how* to use the pesticide include:

BAND—Application to a strip or band over or along each crop row or on or around a structure.

BASAL—Application to stems or trunks at or just above the ground line.

BROADCAST—Uniform application to an entire specified area.

CRACK AND CREVICE—Application in structures to cracks and crevices where pests may live.

DIP—Complete or partial immersion of a plant, animal, or object.

DIRECTED—Aiming the pesticide at a portion of a plant, animal, or structure.

DRENCH—Saturation of the soil with a pesticide or oral treatment of an animal with a liquid pesticide.

FOLIAR—Application to the leaves of plants.

IN-FURROW—Application to or in a furrow in which a crop is planted.

OVER-THE-TOP—Application over the top of a growing crop.

POUR-ON—Pouring the pesticide along the midline of the backs of livestock.

SIDEDRESS—Application along the side of a crop row.

SOIL APPLICATION—Application to the soil rather than to vegetation.

SOIL INCORPORATION—Application to the soil followed by use of tillage implements to mix the pesticide with the soil.

SOIL INJECTION—Application under the soil surface.

SPOT TREATMENT—Application to a small area.

Formulations

A pesticide is rarely used as originally manufactured. It must be diluted with water, oil, air, or other inactive (inert) materials so that it can be handled by application machinery and spread evenly over the area to be treated. The manufacturer often must further modify the product by combining it with other materials such as solvents, wetting agents, stickers, powders, or granules. The final product as it is sold is called a *pesticide formulation*.

A single pesticide is often sold in several different formulations. The applicator should choose the formulation that will best meet the requirements for a particular job.

Considerations in making a choice include:

- Effectiveness against the pest.
- Plant, animal, or surface to be protected.
- Application equipment available.
- Danger of drift and runoff.
- Cost of application.
- Hazards to applicator or to other persons, plants, and animals.

Following are the most common types of formulations. The abbreviations shown are those often used on labels and in recommendations.

Dry Formulations

DUST (D)—This is a finely ground, ready-to-use, dry mixture combining a small amount of active ingredient with an inert carrier such as talc, clay, or volcanic ash. The amount of active ingredient usually ranges from 1 to 10 percent. Some active ingredients are prepared as dusts because they are safer for crops in that form. Dusts must always be used dry. They can easily drift into non-target areas. Consequently, herbicides are never applied as dusts. Dust concentrates are available for further dilution with dry inert ingredients before they are ready to use.

BAIT (B)—Food or another attractive substance is mixed with an active ingredient that will attract and be eaten by pests and cause their death. Baits usually are used to control rodent and insect pests. They can be used in buildings or outdoors. The amount of active ingredient in most bait formulations is quite low, usually less than 5 percent.

GRANULE (G)—This is a ready-to-use dry mixture of a small amount of active ingredient and inert carriers. Most are made by applying a liquid formulation of the active ingredient to coarse particles (granules) of some porous material such as clay, corn cobs, or walnut shells. Granule particles are much larger than dust particles. The pesticide is absorbed into the granule, or coats the outside of it, or both. Inert ingredients may be added to make the formulation handle well. The amount of active ingredient ranges from 2 to 40 percent. They are most often used as soil treatment. They may be applied either directly to the soil or over plants. They do not cling to plant foliage, but they may be trapped in the whorls of some plants. Granular formulations, like dusts, should always be used dry. Never mix them with water.

WETTABLE POWDER (WP or W)—Wettable powder is a dry preparation which may contain 15 to 95 percent active

ingredient (usually 50 percent or more) and is mixed with water for application. These are dry, finely ground pesticide formulations. They look like dusts, but, unlike dusts, they are made to mix with water. Wettable powders form a suspension rather than a true solution when added to water. Good agitation is needed in the spray tank to maintain the suspension. Good wettable powders spray well and do not clog nozzles. They are abrasive to pumps and nozzles.

SOLUBLE POWDER (SP)—This is a dry preparation which may contain 15 to 95 percent active ingredient. Soluble powders are also dry formulations, but, unlike wettable powders, they form a true solution when added to water. Agitation in the spray tank may be needed to get them to dissolve. After dissolving, usually no more agitation is needed. The amount of active ingredient in an SP is usually above 50 percent.

WATER DISPERSIBLE GRANULE OR DRY FLOWABLE—This is a dry formulation usually containing 75 to 90 percent active ingredient and is applied in water. The herbicide is formulated into tiny balls, each about the size of a BB. The formulation pours easily without the windblown dust associated with wettable powders and readily disperses in water to form a suspension.

PELLET (P)—Pellets are similar to granules in that they are ready to use, are applied in the dry form, and contain a small amount of active ingredient (usually 10 to 20 percent by weight) combined with inert carrier. Pellets are usually extruded, with diameters ranging from 1/8- to 3/8-inch and 1/4- to 1/2-inch in length. The Velpar Gridball is an example of a much larger molded pellet. Pelleted formulations may be applied by hand or mechanically and are used for soil treatment. While drift is not a problem with this formulation, pellets should not be applied to frozen soil. Applications made on steep slopes or in close proximity to root systems of non-target plants are special hazards.

Liquid Formulations

Liquid formulations do not exhibit the variety of physical forms possible with dry formulations. However, liquid formulations differ markedly in the nature of their characteristics which influence selection, rate of application, and environmental impact.

WATER SOLUBLE CONCENTRATE—Water soluble concentrates form a solution when added to water and are applied with water as the carrier. These pesticides usually have an amine or metallic salt in the molecule which allows water solubility. These formulations are essentially

non-volatile. There may be 2 to 8 pounds of active ingredient per gallon of formulation. Agitation is not necessary to maintain the pesticide in solution.

EMULSIFIABLE CONCENTRATES (E or EC)—These concentrates are soluble in oil and form an emulsion in water. The emulsion-forming characteristic results from the addition of adjuvants to the pesticide formulation. The milky appearance when mixed with water is typical of emulsifiable concentrates. Usually by-pass agitation is sufficient to keep the emulsion from separating.

OIL-SOLUBLE AMINE CONCENTRATES—This formulation combines the non-volatile characteristic of the amine with oil solubility for bark penetration.

ULTRA-LOW-VOLUME CONCENTRATE SOLUTION (ULV)—This solution contains concentrated active ingredient, usually used without dilution.

FLOWABLE (F or L)—In this formulation very finely ground solid material is suspended in a liquid. Liquid flowables usually contain a high concentration (4 pounds or more) of active ingredient and are mixed with water for application. Some active ingredients can be made only as a solid or, at best, a semi-solid. These are finely ground and put into a liquid along with other substances that make the mixture form a suspension. They seldom clog spray nozzles, and they need only moderate agitation.

LIQUIFIED GASES (FUMIGANTS)—The active ingredient is in the form of either a gas or a liquid which becomes a gas when applied. Some fumigants are gases which become liquid when placed under pressure. This type of formulation is stored under pressure. The pressure may be either high or low, depending on the product. Some nematocides, insecticides, fungicides, and rodenticides are formulated this way. These formulations are applied by injecting them directly into the soil, releasing them under tarps, or releasing them into a structure such as a grain storage elevator.

Some other active ingredients remain liquid in an ordinary container but turn into a gas or vapor as or after they are applied. These formulations do not require storage under pressure. They must be put into the soil or confined in a space before they turn to gas.

AEROSOLS (A)—These pesticide formulations are pressurized liquids that contain the active ingredient dissolved in a solvent. More than one pesticide may be in these formulations. Most aerosol formulations have a low percentage of active ingredient. They are made for use only in fog- or mist-generating machines. They are used in structures, greenhouses, and barns for insect control.

Advantages And Disadvantages Of Formulations

Formulation	Advantages	Disadvantages
Dust	Ready to use; requires no mixing; easy to apply	Drift hazard; expensive
Poisonous bait	Ready to use; easy to apply; controls pests that move in and out of the site	Hazardous to children; pests may prefer crop or food to bait; killed pests may cause odor problem
Granule	Ready to use; easy to apply; can be applied to target under dense foliage; minimize drift	Limited foliage use; expensive per pound active ingredient
Wettable powder	Relatively inexpensive; safer than emulsifiable concentrate to use on tender foliage; easy to measure	Inhalation potential; requires mechanical agitation; difficult to mix; may clog nozzles
Soluble powder	Easy to mix and measure; no agitation required	Inhalation potential
Water dispersible granule or dry flowable	Convenient in handling and mixing; reduced inhalation exposure	Agitation needed; may be slightly more expensive than other dry formulations
Pellet	Ready to use; easily applied by hand; effective spot treatment method	Expensive; hazardous on steep slopes, close to desired plants, and on frozen soil
Water soluble concentrate	Readily mixes with water; equipment cleans up easily; essentially non-volatile	Eye irritation with some salts
Emulsifiable concentrate	High concentration; relatively inexpensive; suitable for low pressure equipment with limited agitation	Volatility potential with some forms; equipment cleaning more difficult; related solvents may cause health or equipment problems
Ultra-low-volume concentrate solution	Ready to use	Phytotoxicity hazard; danger of overdosing; limited uses
Flowable	Can be mixed with water; reduces nozzle clogging; easily measured; no inhalation hazard	Requires agitation
Liquified gas (fumigant)	Toxic to wide range of pests; will penetrate cracks and crevices and grain	Area must be sealed; requires special protective equipment; dangerous

Chapter 2

Test

1. List several pest control methods.

- a. _____
- b. _____
- c. _____
- d. _____
- e. _____
- f. _____
- g. _____

2. Name three main pest control strategies.

- a. _____
- b. _____
- c. _____

3. Match the terms on the right to the correct definitions.

- | | |
|---|----------------------------|
| ___ a. Dries up plant leaves and stems. | 1. Insecticide |
| ___ b. Removes leaves to aid in harvesting. | 2. Miticide |
| ___ c. Kills mites, ticks, and spiders. | 3. Acaricide |
| ___ d. Kills fungi. | 4. Nematicide |
| ___ e. Kills rodents. | 5. Fungicide |
| ___ f. Kills bacteria. | 6. Bactericide |
| ___ g. Kills nematodes. | 7. Herbicide |
| ___ h. Kills weeds. | 8. Rodenticide |
| ___ i. Kills mites. | 9. Avicide |
| ___ j. Kills insects. | 10. Piscicide |
| ___ k. Kills fish. | 11. Molluscicide |
| ___ l. Kills birds. | 12. Predacide |
| ___ m. Keeps pests away. | 13. Repellent |
| ___ n. Kills vertebrate pests. | 14. Pesticide |
| ___ o. Kills mollusks, such as slugs and snails. | 15. Attractant |
| ___ p. Chemicals used to destroy, prevent, or control pests. | 16. Plant growth regulator |
| ___ q. Stops, speeds up, or otherwise changes normal plant processes. | 17. Defoliant |
| ___ r. Lures pests. | 18. Desiccant |

4. Identify terms associated with how pesticides work.

- | | |
|---|----------------------------|
| ___ a. Affect pests by changing their behavior. | 1. Protectants |
| ___ b. Toxic to most plants or animals. | 2. Selective |
| ___ c. Kill plants by being absorbed by leaves, stems, or roots and moving throughout plants. | 3. Sterilants |
| ___ d. Taken into the blood of an animal or sap of a plant; kill the pest without harming the host. | 4. Nonselective |
| ___ e. Gases which kill when they are inhaled or absorbed by the pests. | 5. Systemics |
| ___ f. Prevent normal clotting. | 6. Translocated herbicides |
| ___ g. Applied to plants, animals, structures, and products to prevent entry or damage by a pest. | 7. Contacts |
| ___ h. More toxic to some kinds of plants or animals than to others. | 8. Stomach poisons |
| ___ i. Inhibit pest reproduction. | 9. Fumigants |
| ___ j. Kill pests when swallowed. | 10. Anticoagulants |
| ___ k. Kill pests simply by contacting them. | 11. Pheromones |

5. State the differences between preplant, preemergence, and postemergence.

- a. Preplant _____
- b. Preemergence _____
- c. Postemergence _____

6. List considerations in choosing the best pesticide formulation for a job.

- a. _____
- b. _____
- c. _____
- d. _____
- e. _____
- f. _____

7. Match the types of pesticide formulations on the right to the correct description.

- | | |
|---|---------------------------------------|
| _____ a. Dry preparation which contains 15 percent to 95 percent active ingredient and must be mixed with water to form a suspension for application. | 1. Aerosol (pressurized can) |
| _____ b. Small amount of pesticide or combination of pesticides that is driven through a fine opening by a gas under pressure when the nozzle is triggered. | 2. Aerosol (generator) |
| _____ c. Dry preparation which contains 15 percent to 95 percent active ingredient; dissolves in water to form a solution. | 3. Dust (D) |
| _____ d. Low-concentrate solution of pesticide; usually in an oil solution formulated especially for use in fog generators. | 4. Poisonous bait |
| _____ e. Pesticide in the form of either a poisonous gas or a liquid which becomes a gas when applied. | 5. Granule (G) |
| _____ f. Finely ground dry mixture combining a small amount of pesticide with an inert carrier such as talc, clay, or volcanic ash. | 6. Emulsifiable concentrate (EC or E) |
| _____ g. Very finely ground solid material which is suspended in a liquid; usually contains high concentration or large amount of active ingredient and must be mixed with water for application. | 7. Ultra-low volume concentrate (ULV) |
| _____ h. Food or other substance mixed with a pesticide that will attract and be eaten by pests and cause their death. | 8. Flowable (F) |
| _____ i. Dry, ready-to-use mixture of a small amount of pesticide and inert carriers. All particles are larger than dust particles. | 9. Wettable powder (WP or W) |
| _____ j. Solution which contains almost pure active ingredient; usually used without dilution. | 10. Soluble powder (SP) |
| _____ k. Solution which contains a high concentration of active ingredient which can be mixed with water or oil; forms milky solution when added to water. | 11. Fumigant |

8. Discuss the advantages and disadvantages of the following formulations.

Formulation	Advantages	Disadvantages
a. Granule		
b. Emulsifiable concentrate		
c. Wettable powder		

9. Match the methods of pesticide application on the right to the correct description.

- | | |
|--|------------------------|
| ___ a. Complete or partial immersion of a plant, animal, or object in a pesticide. | 1. Band |
| ___ b. Application to a small area. | 2. Broadcast |
| ___ c. Aiming the pesticide at a portion of a plant, animal, or structure. | 3. Dip |
| ___ d. Application to the soil followed by use of tillage implements to mix the pesticide with the soil. | 4. Directed |
| ___ e. Saturation of the soil with a pesticide or oral treatment of an animal. | 5. Drench |
| ___ f. Application along the side of a crop row. | 6. Foliar |
| ___ g. Application to the leaves of a plant, shrub, or tree. | 7. In-furrow |
| ___ h. Pouring the pesticide along the midline of the back of livestock. | 8. Over-the-top |
| ___ i. Application to a strip or band over or along each crop row. | 9. Pour on |
| ___ j. Application over the top of the growing plant. | 10. Sidedress |
| ___ k. Uniform application to an entire specified area. | 11. Soil incorporation |
| ___ l. Application to or in a furrow in which a crop is planted. | 12. Spot treatment |

Chapter 3

Labels And Labeling

Objectives

After completing this unit, the trainee will:

- Match terms associated with labels and labeling to the correct definitions.
- Differentiate between general use and restricted use pesticides.
- Identify the factors that form the basis for pesticide classification.
- Read and interpret accurately the information contained on a pesticide label.
- Match the signal words found on labels to their toxicity categories.
- Identify the times when an applicator should read the label for guidance on the use of a pesticide.

Introduction

Each time you buy a pesticide, you also receive instructions to tell you how to use it. The pesticide label describes the risks and benefits of the pesticide product to the user. The label is not only the primary source of information to the user, but it is also the primary tool of pesticide regulation. The combined knowledge of many people in industry, universities, and government is used to develop the information on the label. This information will tell you how to use the product safely and correctly.

Labeling is all the information that you receive from the company or its agent about the product. Labeling includes such things as the label on the product, brochures, flyers, and information handed out by your dealer. It must not differ in meaning from the information furnished to EPA when the product was registered.

The time you invest in reading the label is probably the most valuable few minutes you can spend in pest control. This small investment of time will help you avoid injuring yourself or the environment by misusing the pesticide.

The label is different things to the different people or groups involved in the sale and use of the pesticide.

- To the manufacturer, the label is a "license to sell."
- To the state or federal government, the label is a way to control the distribution, storage, sale, use, and disposal of the product.
- To the dealer and user, the label indicates whether the pesticide is for restricted or general use, and whether certification is required.
- To the buyer or user, the label is a main source of facts on how to use the product correctly and legally. It is a way to tell users about special safety measures needed.
- To dealers and pest control experts, the label is an aid in making recommendations to buyers and users.

- To physicians, the label is a way to determine what antidote or first aid procedure to use in the treatment of poisoning cases.

Parts Of The Label

Some labels are easy to understand, while others are more complicated. Federal regulations require certain information to appear in certain locations on the label. This is known as *format* labeling. The concept of format labeling was developed to help you read the label. If pesticide users know where to look on labels for specific kinds of information, they should better understand the correct use of pesticides. See example on page 20.

Brand Or Trade Name

A brand name is a name used by a manufacturing firm to identify a pesticide as its product. It is the most identifiable name for the product. Brand names are usually capitalized. Example: Karmex.

A brand name cannot be used in the ingredient statement but usually appears in large, boldfaced letters on the packaging. One brand name, such as Ortho, may appear on the label of several kinds of pesticide chemicals.

Chemical Name

The chemical name is the scientific name for an active ingredient. Example: 3-(3,4-dichlorophenyl)-1,1-dimethylurea.

Common Name

A common name is a well-known, made-up name accepted by the Environmental Protection Agency to identify an active ingredient. Common names are usually not capitalized. Example: diuron.

When an accepted common name is available, it must be used with the chemical name in the active ingredients section on the label. If there is no common name, the chemical name alone must be used.

Type Of Pesticide Formulation

Different types of pesticide formulations (such as liquids, wettable powders, and dusts) require different methods of handling. The label will tell you what type of formulation the package contains. The same pesticide may be available in more than one formulation.

Ingredient Statement

Every pesticide label must list what is in the product. The list is written so that you can see quickly what the ac-

The active ingredient must be listed by chemical name and common name (if one is designated). Inert ingredients need not be named, but the label must show their percentage of the total contents.

The net contents statement tells how much is in the container. For example, if the product is a liquid, the net content would be in terms of liquid measure and would be expressed in conventional American units of fluid ounces, pints, quarts, and gallons. Net content is always stated in terms of the largest suitable units, such as "1 pound" rather than "16 ounces."

The law requires the manufacturer or distributor of a product to put the name and address of the company on the label. This way, you will know who made or sold the product.

A registration number must be on every pesticide label. It shows that the product has been registered with the U. S. Environmental Protection Agency (EPA). It usually is found on the front panel of the label and will be written as "EPA Registration No. 0000-00." The establishment number tells what factory made the chemical. This number

If a poisoning occurs, it is important to know either the common name or the chemical name of the active ingredients, the manufacturer's name, and the EPA registration number. This information is vital and should be given to a physician, poison control center, or other person who requests information about the pesticide.

Signal Words And Symbol

To be effective, pesticides must control the target pest. By nature, pesticides are toxic. Therefore, some may be hazardous to people. You get an idea of the toxicity of a product by reading the signal word and looking at the symbol on the label.

There are three general categories of pesticides based on toxicity. Signal words are an indication of the degree of toxicity to people.

A knowledge of the meaning of the signal words and symbol warns the user of potential hazards associated with the pesticide. These are only categories, however, and there is considerable range in the toxicity of the various pesticides that fall in each group.

The signal words that follow are set by law. Each manufacturer must use the correct one on every label.

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Signal Word	Toxicity	Approximate Amount Needed To Kill a 150-Pound Person
DANGER	Highly toxic	A taste to a teaspoonful
WARNING	Moderately toxic	A teaspoonful to a tablespoonful
CAUTION	Low toxicity or comparatively nontoxic	An ounce to more than a pint

Unqualified claims for safety are not acceptable on any labels. All labels must bear the statement, "KEEP OUT OF REACH OF CHILDREN."

Symbol

The skull and crossbones symbol is used on the label of highly toxic materials along with the signal word, DANGER, and the word, POISON (in red).

Precautionary Statements

Hazards To Humans (and Domestic Animals)

This section on the label will tell you the ways in which the product may be poisonous to human beings and animals. It also will tell you of any special steps you should take to avoid poisoning, such as the kind of protective equipment needed. If the product is highly toxic, this section will inform physicians of the proper treatment for poisoning.

Environmental Hazards

Pesticides are useful tools. But wrong or careless use could cause undesirable effects. To help prevent problems, the label contains environmental precautions that you should read and follow.

Here are some examples:

- "This product is highly toxic to bees exposed to direct treatment or to residues on crops."
- "Do not contaminate water when cleaning equipment or when disposing of wastes."
- "This product is highly toxic to fish and wildlife."

Labels may contain broader warnings against harming birds, fish, and wildlife.

Federal law now requires that pesticide labels warn users of potential hazards to protected or endangered species in certain geographical areas. For example, the Scout insecticide label warns users in Lauderdale, Limestone, and Madison Counties about the potential hazard to the slack water darter. Other statements that alert users to concerns about endangered species might say:

Endangered Species Restrictions: For Aerial Applications—Do not use within 100 yards of aquatic habitats. For Ground Applications—Do not use within 20 yards of aquatic habitats.

Physical And Chemical Hazards

This section on the label will tell you of any special fire, explosion, or chemical hazards that the product may pose.

Statement Of Practical Treatment

If swallowing or inhaling the product or getting it in your eyes or on your skin would be harmful, the label will give you emergency first aid measures. It will also tell what types of exposure require medical attention.

The pesticide label is the most important information you can take to the physician when you think someone has been poisoned. If the product is highly toxic, this section on the label will inform physicians of the proper treatment for poisoning.

Statement Of Use Classification

To sell a pesticide, a manufacturer must submit information to EPA about its toxicity, hazards, and effectiveness. EPA uses this information to decide whether to register the pesticide (approve it for sale) and whether it should be sold for *general* or *restricted* use.

EPA considers three factors in deciding whether to classify a pesticide as *general* or *restricted* use:

- The hazard of poisoning.
- The way the pesticide is used.
- Its effects on the environment.

General Use

A general use pesticide is one which will not generally cause unreasonable adverse effects on the environment when used in commonly recognized practices in accordance with its labeling. Such pesticides normally will be available to the public.

Restricted Use

A restricted use pesticide is one which could cause some human injury or environmental damage even when used as directed on the label. The label on these products will say:

Restricted use pesticide for retail sale to and application only by certified applicators or persons under their direct supervision.

The restricted use statement must be at the top of the front panel of the label.

EPA limits the use of these pesticides to certified applicators. Some products may be used only by some categories of certified applicators. The label will state clearly who may use the product.

Directions For Use

The use instructions will tell you:

- The pests the product is registered to control.
- The crop, animal, or other item the product can be used on.
- In what form the product should be applied.
- How much to use.
- Where the material should be applied.
- When it should be applied.

Directions For Use By Reference

In addition to label directions, pesticide users must also obey directions contained in documents that are only

referred to on the product labeling. This practice has become necessary because there is no longer room on the traditional label to explain the requirements of all laws and regulations. A referral might say:

Use of this product in a manner inconsistent with the PESTICIDE USE BULLETIN FOR PROTECTION OF ENDANGERED SPECIES is a violation of federal laws. Restrictions for the protection of endangered species apply to this product. If restrictions apply to the area in which this product is to be used, you must obtain the PESTICIDE USE BULLETIN FOR PROTECTION OF ENDANGERED SPECIES for that county.

This statement would probably be the **ONLY** indication in the labeling material that other use directions and restrictions apply to the product.

You are responsible for determining whether the regulation, bulletin, or other document referred to on the pesticide product labeling applies to your situation and your intended use of the product. If the document is applicable, you must comply with all the specific directions for use and other requirements that it contains. These documents do not always accompany the pesticide product when it is sold. Instead, you may have to get the additional directions and requirements from other sources, such as pesticide dealers or company representatives, industry or commodity organizations, land-grant universities, or your county Extension agents.

Misuse Statement

This section on the label will remind you that it is a violation of Federal law to use a product in a manner inconsistent with its labeling. Do not use a product on a crop or for a pest not listed on the label. Do not use it at more than the recommended rate. Before the product can be registered, EPA requires the manufacturer to conduct many tests to be sure the label directions are correct. By following them exactly, you will get the best results the product can give and avoid breaking the law.

No pesticide may legally be used or recommended in any way that conflicts with the recommendations on the registered label. Illegal uses or recommendations are any that:

- Increase the rate of application over the maximum shown on the label.
- Change the method, time of application, or other conditions of use shown on the label.
- Include a crop to be treated that is not shown on the label.

However, it is not illegal to use a pesticide:

- At rates less than those recommended on the label.
- Less frequently than recommended on the label.
- For a pest unnamed on the label if the site of application is listed on the label.
- In combination with fertilizers.
- In combination with other pesticides, providing that labeled rates for each pesticide are not exceeded and the combination of products is not prohibited by any of the pesticide labels.

Reentry Statement

If required for the product, this section on the label will tell you how much time must pass before a pesticide-treated area is safe for entry by a person without protective clothing. Consult local authorities for special rules that may apply.

Waiting Periods

If required for the product, this section will tell you how much time must pass between pesticide application and harvest, slaughter, or grazing.

Category Of Applicator

If required for the product, this section will limit use to certain categories of commercial applicators.

Storage And Disposal Directions

Every pesticide should be stored and disposed of correctly. This section will tell you how to store and dispose of the pesticide and empty containers.

When To Read The Label

Read the label *before purchasing* the chemical to determine:

- If this is the chemical you need for the job. Never depend on the color of the label or on the product name (such as Raid, Ortho) when you purchase or select a pesticide. Labels of the same color and general makeup may contain widely different active ingredients.
- If this material is too toxic or hazardous to be used safely under your conditions.
- The concentration in percent or pounds per gallon of active ingredient.
- If the formulation is suitable for your equipment and the situation in which it will be applied.

Read the label *before you prepare the material for use* to determine:

- Necessary protective equipment for safe handling.
- Warnings and antidotes, when required.
- What you can mix with it (compatibility).
- How much to use.
- To what it can be applied.

Read the label *before applying* to determine:

- Safety measures necessary for applicator.
- When to apply, including waiting period for crops and animals.

- How to apply.
- Rate of application.
- Restrictions of use.
- Special instructions.

Read the label *before storing or disposing of the pesticide and container* to determine:

- Where and how to store.
- Where it should *not* be stored.
- What it should *not* be stored with.
- How to decontaminate and dispose of the container.
- Where to dispose of leftover pesticides or their containers.

Chapter 3

Test

1. Match the terms on the right to the correct definition on the left. Place the appropriate numbers in the blanks provided.

- | | |
|--|-----------------|
| <input type="checkbox"/> a. Technical information in the form of printed material provided by the manufacturer or its agent. | 1. Label |
| <input type="checkbox"/> b. Words which must appear on pesticide labels to show toxicity of pesticide. | 2. Signal words |
| <input type="checkbox"/> c. Form of printed material attached to or printed on a pesticide container. | 3. Labeling |
| <input type="checkbox"/> d. Period of time between a pesticide application and when workers can safely go back into the area without wearing protective clothing or equipment. | 4. Reentry |

2. Match the users of the label on the right to the ways the labels are used on the left. An answer may be used more than once.

- | | |
|---|-------------------------------------|
| <input type="checkbox"/> a. Use the label to control sale, use, safety, storage, and disposal of pesticides. | 1. State and federal governments |
| <input type="checkbox"/> b. Use the label as the license to sell a pesticide. | 2. Manufacturers of pesticides |
| <input type="checkbox"/> c. Use the label to determine the antidote to use in the proper treatment of poisoning cases. | 3. Dealers and pest control experts |
| <input type="checkbox"/> d. Use the label as a way of deciding which pesticide will be effective against the pest and be the safest to use. | 4. Physicians |
| <input type="checkbox"/> e. Use the label to decide what safety precautions to take and how much pesticide to use. | 5. Buyers and |
| <input type="checkbox"/> f. Use the label to aid in making recommendations to buyers and users. | |

3. Select from the list below the agency in the federal government responsible for registering labels.

- ☐ a. U.S. Department of Agriculture
- ☐ b. State Department of Agriculture
- ☐ c. Environmental Protection Agency
- ☐ d. Environmental Control Agency

4. Match the correct signal word with the corresponding toxicity category.

- | | |
|--|------------|
| <input type="checkbox"/> a. Highly toxic | 1. Caution |
| <input type="checkbox"/> b. Moderately toxic | 2. Danger |
| <input type="checkbox"/> c. Slightly toxic | 3. Warning |

5. Name the three factors that determine a pesticide's classification as general or restricted.

- a. _____
- b. _____
- c. _____

6. Name four times the applicator should read the label.

- a. _____
- b. _____
- c. _____
- d. _____

7. Distinguish between general use and restricted use pesticides by placing an "X" in the blank indicating general use pesticide.

- ☐ a. Pesticide use that may cause unreasonable adverse effects on the environment, including injury to the applicator, unless it is regulated by other methods besides labeling.
- ☐ b. Pesticide use that will not generally cause unreasonable adverse effects on the environment when used in commonly recognized practices in accordance with its labeling.

Chapter 4

The Environment

Objectives

After completion of this unit, the trainee will:

- Match terms related to the environment with the correct definitions.
- Know how pesticides can harm the environment.
- Know how pesticides can move in the environment.
- Understand how pesticides move in soil and air.
- Understand how pesticides can contaminate water.
- Know how pesticide usage should be modified in the habitats of endangered species.
- Name ways pollinating insects can be protected from pesticides.

Introduction

"Environment" and "ecology" are terms that have been used for many years by scientists. Today, they are words that belong in everyone's vocabulary.

The "environment" is the world around us and the many forms of life it contains. Every plant and animal is affected by other plants or animals in the environment. Factors like rain, temperature, and wind are part of the environment. The environment is in a constant state of change. Plants and animals within an area increase or decrease in numbers. Materials are both produced and used up. Human beings are just as closely tied into this system as any other animal.

Ecology is a complex science which deals with the study of organisms in relation to their environment.

An ecosystem is a community of organisms considered in relationship not only with each other but with the nonliving parts of their environment. An ecosystem can be as small as a tidal pool or as large as a desert.

Environmental Problems With Pesticides

The need to control pests has led to widespread use of many chemical pesticides. Many people consider pesticides a tool for preserving or improving the environment. Their benefits have included saving millions of lives and allowing greatly increased agricultural production. On the other hand, there is increasing concern about the effects of these chemicals on the environment and on human health.

The environmental problems brought about by the misuse of pesticides are varied. Any pesticide can cause harm if not chosen and used with care. You are legally liable to fines and/or prison terms if you do not follow

label instructions when using a pesticide. Here are some ways damage can occur.

Direct Kill Of Nontarget Organisms

Avoid allowing a pesticide to contact anything except the target area. Drift from pesticides can injure nearby plants and animals. Herbicide drift can injure or kill nearby crops, trees, and ornamental plantings. Pesticides are sometimes applied over a large area. Take precautions to avoid harming nontarget plants and animals within the treated area.

Runoff from the sprayed area can kill fish and other aquatic life in a nearby stream or pond. Life in streams can also be harmed by careless tank filling or draining and improper container disposal. Careless pesticide application resulting in injury to the environment can result in lawsuits, fines, and loss of certification.

If more than one pesticide will control the target pest, choose the one that is the least hazardous to the environment and safest in the situation.

Persistence And Accumulation

Not all pesticides act the same after you apply them. Most are in one of these groups:

Nonpersistent Pesticides

Nonpersistent pesticides are pesticides that break down quickly. They remain on the target or in the environment only a short time before breaking down into harmless products. Some of these are highly toxic when applied. Others are relatively nontoxic.

Persistent Pesticides

Persistent pesticides are pesticides that break down slowly. They may stay in the environment without change for a long time. Often this quality is desirable for long-term control. Usually, persistent pesticides are not broken down easily by microorganisms and are only slightly soluble in water.

Some persistent pesticides can injure sensitive plants planted on the same soil the next year, but they are not hazardous to the environment. Other persistent pesticides can build up in the bodies of animals, including human beings. They may build up until they are harmful to the animal itself or to the meat-eater that feeds on it. These are called accumulative pesticides.

Pesticide Movement in the Environment

Pesticides become problems when they move off target. This may mean:

- Moving out of the target area as mist or dust (drift).
- Moving on the soil surface through runoff or erosion.
- Moving through the soil in water (leaching).
- Being carried out as residues in crops and livestock.
- Evaporating and moving with air currents (volatilization).

Soil And Pesticides

Persistent pesticides may limit future planting. You can plant only crops which the pesticide will not kill or contaminate.

Even pesticides directed at plants or animals can move to the soil. They may be washed or brushed off. They may be worked into the soil with dead plant parts.

Despite the method of application, portions of all pesticide sprays reach the soil. A pesticide deposited on foliage, for example, may be washed off onto the soil by rainfall. The effects of a pesticide on the environment depend greatly on what happens to the pesticide in the soil.

Surface Water And Pesticides

Most fish and other aquatic life can survive only slight changes in their environment. Even tiny amounts of many pesticides can harm them or destroy their food. They may die at once, or there may be chronic effects. The behavior of an animal can be changed so that predators can more easily catch and kill it. Pesticide-contaminated eggs may not hatch.

Pesticides in water may also harm other wildlife. Polluted irrigation water can harm crops, soil, and livestock. It can cause illegal residues in crops, milk, and meat.

The sprayer filling station can be designed to minimize problems. Filling stations are often placed on pond or stream banks where the natural flow is back into the water. Grading the area to slope away from the water will prevent this problem and allow you to neutralize spills so that they do no damage.

Groundwater And Pesticides

The subject of groundwater contamination has been the topic of much discussion by scientists, environmentalists, and regulatory officials. An attempt is being made to assess the problem by identifying aquifers (water-bearing layers of rock, gravel, or sand) and monitoring their contamination levels.

Groundwater is used by 52 percent of Alabama's population. It has been estimated that total usage in Alabama amounts to 290 million gallons per day. Most cities on the Alabama Coastal Plains depend solely on groundwater for their water supplies. Exceptions are Mobile, Tuscaloosa, and Phenix City. Montgomery uses both ground and surface water. In Madison County, the water levels decline in response to increased pumping but tend to recover when pumping is reduced.

The public water section of the water division of the Alabama Department of Environmental Management (ADEM) regulates public water supplies. Their regula-

tions are aimed primarily at potability and adequacy to meet demands. ADEM certifies well drillers and develops standards. Permits from ADEM are required for any well within coastal area zones that produces 50 gallons per minute or more. ADEM investigates reports of groundwater contamination and has the authority to close wells that produce water that is hazardous for human consumption. Self-supplied industrial, commercial, and agricultural users of groundwater are not regulated in Alabama.

ADEM has contracted with the U.S. Geological Survey to investigate possible contamination problems. Pinpointing problem chemicals and geographical areas is one goal. If residues are found during groundwater monitoring, EPA's regulatory options are suspension, cancellation, restriction to certain geographic locations, or continuation of the present registration, depending on the severity of the problem. Label warnings regarding groundwater contamination are being required on pesticides that present the greatest risk.

The potential for a pesticide to contaminate groundwater depends on its persistence and solubility in water. Pesticide persistence is often expressed as half-life (time required for one half of the original amount of pesticide to degrade). Below are some examples:

Table 1.

Non-persistent (half-life of 30 days)	
2,4-D	propachlor (Ramrod)
alachlor (Lasso)	vernolate (Vernam)
butylate (Sutan +)	carbaryl (Sevin)
cyanazine (Bladex)	captan
EPTC (Eptam)	diazinon
metribuzin (Sencor, Lexone)	malathion
oryzalin (Surflan)	phorate (Thimet)
Moderately Persistent (half-life of 30 to 99 days)	
acifluorfen (Blazer)	trifluralin (Treflan)
atrazine (AATrex)	aldicarb (Temik)
bentazon (Basagran)	carbofuran (Furadan)
glyphosate (Roundup)	chlorpyrifos (Lorsban)
linuron (Lorox, Linex)	endrin
metolachlor (Dual)	fonofos (Dyfonate)
simazine (Princep)	
Persistent (half-life of 100 days or more)	
paraquat (Gramoxone)	prometon (Pramitol)
picloram (Tordon)	lindane
bromacil (Hyvar)	chlordan

The solubility of a pesticide can be determined by a value called the partition coefficient. A pesticide with a lower partition coefficient is more likely to dissolve in water and leach through the soil into groundwater. Selected pesticides and their partition coefficients (PC) are as follows:

Table 2.

Pesticide	PC
dicamba (Banvel)	11
aldicarb (Temik)	12
picloram (Tordon)	26
carbofuran (Furadan)	29
2,4-D	32
captan	33
fonofos (Dyfonate)	68
simazine	163
cyanazine (Bladex)	168
alachlor (Lasso)	190
carbaryl (Sevin)	229
prometon (Pramitol)	300
diuron (Karmex)	383
hexazinone (Velpar)	383
diazinon	580
glyphosate (Roundup)	2,640
methyl parathion	7,000
chlorpyrifos (Lorsban)	13,500
paraquat (Gramoxone)	15,000
chlordane	38,000

A geographic area's vulnerability to groundwater contamination by pesticides depends on soil properties, geographic and climatic conditions, and agricultural practices. The greatest vulnerability would be found under the following conditions:

- 1) sandy soil
- 2) low organic-matter content
- 3) shallow groundwater
- 4) wet climate or extensive irrigation
- 5) pesticide application by injection or incorporation
- 6) persistent, water-soluble pesticides

If a pesticide residue is found in groundwater, it is not necessarily the result of routine agricultural applications. Pesticides also get into groundwater in the following ways:

1) Back-siphoning from a spray tank into well water. Never let the fill hose become submerged in the pesticide tank.

2) Faulty chemigation (chemical application through irrigation water) equipment. Always install a check valve.

3) Dumping pesticide waste and containers into sink holes or other soil depressions that funnel rain water underground. Dispose of pesticide waste and "empty" containers properly.

4) Applying excessive amounts of pesticides. Follow label directions and calibrate application equipment.

5) Careless use of pesticides around well heads.

When filling from a well, use a separate pump with check valves to prevent back-siphonage, and be sure the filler hose does not dip into the sprayer tank. If you mount the right size hook to hold the filler hose, you won't have to hold it, and there will be no chance of its dipping into the tank. Be sure your sprayer doesn't overflow and drain pesticide-contaminated water back into the well. If the well you are using is the source of domestic

water or water for cattle, you may want to fill elsewhere. Even if you fill elsewhere, you should take the same precautions.

What do you do if you contaminate the well? First, contact your county or state health official. Usually the remedies will depend somewhat on the toxicity of the pesticide and how tightly it attaches to particles in the water and to the walls of the well. With materials of low or moderate toxicity, the well should be pumped dry, allowed to recover, and pumped again. The addition of a charcoal slurry will help absorb the pesticide. Chlorine compounds may help break down the pesticide.

The well should be pumped dry after the addition of any of these absorbents or neutralizers. Plumbing should be thoroughly flushed after the well is decontaminated and before any water is used. A chemical analysis should be made before the water is used. If the well cannot be purified, you may be liable for a new water supply.

Water is a basic element of all life; water quality affects all plant and animal life. Pesticide applicators have a responsibility to protect our groundwater resources.

Endangered Species And Pesticides

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) is attempting to aid in the protection of the total environment. One phase of the act involves aiding other federal statutes such as the 1973 Endangered Species Act. This act requires that all species of fish, wildlife, and plants threatened with extinction will be conserved and protected by all federal departments and agencies, as well as by state agencies receiving federal funds.

An endangered species is a plant or animal that is in danger of becoming extinct. There are two classifications of these plants and animals: "endangered species" and "threatened species." The term "endangered species" is used here to refer to plants and animals in both classifications.

Scientists believe that some pesticides may threaten the survival of endangered species if they are used in the places where these plants and animals still exist. As a result, the Endangered Species Act requires EPA to ensure that endangered species are protected from pesticides. It is important that each species is allowed to survive. The extinction of a single species may set off a chain reaction of harm to other species. The disappearance of a single kind of plant from an area, for example, may lead to the disappearance of certain insects, higher animals, and other plants.

FIFRA is requiring label revision on pesticide labels to warn users that the product is capable of adversely affecting an endangered species. The warning statement will instruct users to obtain a county bulletin which will give specific instructions. It will be the responsibility of the applicator to obtain more information by reading county bulletins which will be developed for each county in the United States. The local county Extension agent's office will be one distribution point for these bulletins.

The federal endangered and threatened species list continues to grow. Some of those found in Alabama are listed on the following page.

Some Endangered And Threatened Animal And Plant Species Found In Alabama

Indiana Bat	American Alligator
Gray Bat	Eastern Indigo Snake
Alabama Beach Mouse	Kemp's Ridley Sea Turtle
Perdido Key Beach Mouse	Leatherback Sea Turtle
Florida Panther	Loggerhead Sea Turtle
Red Wolf	Red Hills Salamander
Bald Eagle	Alabama Cavefish
Peregrine Falcon	Spotfin Chub
Brown Pelican	Slackwater Darter
Wood Stork	Snail Darter
Backman's Warbler	Watercress Darter
Ivory-billed Woodpecker	Green Pitcher Plant

Habitats, sometimes called "critical habitats," are the areas of land, water and air space that an endangered species needs for survival. The U.S. Fish and Wildlife Service is responsible for identifying the current habitat or range of each endangered species. For aquatic species, the restricted habitat will often include an additional zone around the body of water to keep any drift, runoff, or leached material in the watershed from reaching the water.

The loss of critical habitat and changes in the quality of that habitat are the major cause of endangerment. One of the challenges is for individual landowners to be aware of the various animals and plants that exist on their land and the effects of habitat changes. The proper use of pesticides is only one factor in protection of endangered species.

Read all pesticide labeling carefully to find out whether the use of that product requires you to take any special steps to protect endangered species. The label may direct you to another source for the details about what you must do. When limitations do apply, they usually will be in effect only in some specific geographic locations. Use of a particular pesticide is usually prohibited in a particular location when: (1) the site is designated as the current habitat of an endangered species, and (2) the endangered species that uses the site might be harmed by the use of the pesticide within or close to its habitat.

As a certified applicator, you have a clearly defined legal responsibility to protect endangered species against the hazards posed by pesticides. Careful use of pesticides in and around key habitat areas will help these fragile plants and animals to survive, and it also may prevent some important pesticides from being removed from the market.

Two Alabama Agricultural Experiment Station publications, *Vertebrate Animals of Alabama in Need of Special Attention* and *Endangered, Threatened, and Special Concern Plants of Alabama*, will aid in the identification of plants and animals on the list. Each Extension office should have a file for reference and keep private applicators aware of these species.

Air And Pesticides

Pesticides in the air cannot be controlled. The pesticides can settle into water, crops, trees, houses, or barnyards. The wind can carry them hundreds of miles. Even gentle breezes can carry them away from the target.

Drift

When herbicides are applied as sprays, air currents may carry the moving spray droplets through the atmosphere beyond the target. This movement is "drift." Almost any pesticide application will result in some drift, which can be serious or relatively harmless.

Drift increases:

- As the distance from the spray nozzle to the ground increases.

- As droplet or particle size decreases.

- As wind speed increases.

It can be minimized if you:

- Spray at low pressure.

- Use the largest practical nozzle openings.

- Use spray additives to increase solution cohesion.

- Spray during the calmer parts of the day.

For example, spray drift is usually greatest from aerial application. Not only is the aerial spray equipment operated at a greater distance from the surface being sprayed, but air currents produced by the moving plane add to the effects of natural winds on the spray.

Ideally, you should work when there is little wind. Practically speaking, this is not often possible. If there are sensitive areas downwind (such as homes, pastures, water, and sensitive crops), work when there is little or no wind, usually in early morning or in the evening. Less-sensitive areas, where the risk is less, can be treated when the weather conditions are not as good. Attachments or modifications to spray equipment, especially to ground rigs, can often be used to reduce spray drift. Shielded booms are the attachments most frequently used for this purpose.

Vaporization

Vaporization is the evaporation of an active ingredient during or after application. Pesticides can move in the air because of the diffusion of vapors and because of wind action on vapors. Pesticide vapors can rise into the atmosphere from plant or soil surfaces. Vaporization increases as air temperature and surface temperature increase. Vapor losses are reduced or stopped when the pesticides attach to plant and soil surfaces, or penetrate the foliage or soil. Vaporization is not as common as particle drift, but it has more potential for moving a greater distance. Vaporization can be reduced by choosing non-volatile pesticide formulations.

Hazard To Pollinators

Honey bees and other insects that pollinate plants play a vital role in the production of many crops. The annual value of Alabama crops requiring or benefiting from insect pollination is about \$400 million. Honey bees account for at least 85 percent of the pollination of plants

that require or benefit from insect pollination. Approximately one-third of all food items come directly or indirectly from insect-pollinated plants.

To protect honey bees from pesticides while controlling the harmful pests requires knowledge of both groups of insects, as well as the flowering habits of plants and the toxicity of pesticides to bees. The toxicity to bees of individual pesticides varies greatly, but as a group, the insecticides are the most toxic. Herbicides, as a group, are much less hazardous, but paraquat and MSMA can cause serious bee kills. Herbicides damage bees most by killing the plants that produce nectar and pollen that they feed on.

The following are some of the points pesticide applicators should keep in mind in order to keep bee kills at a minimum.

- Bees are less likely to be affected by pesticides applied in the very late afternoon or night because they are not actively foraging at those times.

- If possible, avoid making pesticide application when crops (or nearby weeds) are in bloom.

- When all recommended pesticides for the control of a particular pest are equally hazardous to honey bees, use the one that has the shortest residual action to bees.

- Microencapsulated pesticides and dusts are formulations particularly hazardous to bees.

- Beekeepers may be able to take steps to prevent bee kills. Familiarize yourself with beekeepers in the area and warn them in advance of applying hazardous pesticides.

Chapter 4

Test

1. Match the terms with their definitions:

___ Environment

___ Ecology

___ Ecosystem

___ Persistent Pesticides

___ Accumulative Pesticides

A. Community of organisms considered in relationship to each other and their environment.

B. Study of organisms in relation to their environment.

C. Pesticides that build up in the bodies of animals.

D. Our surroundings, including other organisms.

E. Pesticides that stay in the environment without change for long periods of time.

2. Name five ways pesticides can move from their target area.

- a. _____
- b. _____
- c. _____
- d. _____
- e. _____

3. Name four ways you minimize drift.

- a. _____
- b. _____
- c. _____
- d. _____

4. List four ways pesticide applicators can avoid major bee kills.

- a. _____
- b. _____
- c. _____
- d. _____

5. Which factors are conducive to groundwater contamination?

- a. sandy soil
- b. high organic-matter content
- c. shallow groundwater
- d. wet climate or extensive irrigation
- e. non-soluble pesticide

6. Which of the following may contribute to contamination of groundwater?

- a. improper disposal
- b. faulty chemigation
- c. pesticide spills near a well head
- d. back-siphoning
- e. excessive rates

Chapter 5

Applicator Safety

Objectives

After completing this unit, the trainee will:

- Describe the protective clothing needed for particular methods of applying pesticides.
- Match terms associated with pesticide safety to the correct definitions.
- Describe first aid measures to be taken in cases of pesticide poisoning.
- Identify the symptoms and causes of pesticide poisoning.
- Explain how to safely mix and load pesticides.

Introduction

There are two good reasons for using pesticides safely: (1) to keep yourself and others from being poisoned and (2) to avoid harming the environment. Pesticides are toxic and can cause injury. Manufacturers find out how toxic a pesticide is by testing it on animals. The product's hazard—the danger that injury will occur to human beings—depends on the toxicity of the active ingredient plus the exposure to the product during use.

Most pesticides can cause severe illness, or even death, if misused. But every registered pesticide can be used safely if you use proper care.

Children under 10 are the victims of at least half of the accidental pesticide deaths in this country. If pesticides were always cared for correctly, children would never touch them.

Many accidental pesticide deaths are caused by eating or drinking the product. But some mixers, loaders, and applicators die or are injured when they breathe a pesticide vapor or get a pesticide on their skin. Repeated exposure to small amounts of some pesticides can cause sudden severe illness.

Most pesticides can enter the body through the skin. More may get into your body this way than by accidentally swallowing or inhaling them while working. With some pesticides, skin contact alone can cause death.

You can help prevent all accidents with pesticides, by using and storing pesticides away from children and other untrained persons and by taking care to follow directions when using them.

Products for restricted use need special care. The label is your guide.

Toxicity And Hazard

Toxicity is not the only factor that determines how dangerous a chemical is to human beings or other animals.

Anyone who handles pesticides should also be concerned with the hazard of the chemical. The terms *toxicity* and *hazard* do not mean the same thing. Toxicity is the capacity of a substance to produce injury or death. Hazard includes two factors—toxicity and exposure. It is the possibility that injury will result from the use of a substance in a given formulation, quantity, or manner.

Some hazards do not involve toxicity to humans or other animals. For example, sulfur, oils, and many other chemicals are considered safe or relatively safe to animals but may pose considerable hazards to some plants (phytotoxicity).

A pesticide may be extremely toxic but present little hazard to the applicator or others when used:

- In a very dilute formulation.
- In a formulation that is not readily absorbed through the skin or readily inhaled.
- Only occasionally and under conditions to which human beings are not exposed.
- Only by experienced applicators who are properly equipped to handle the chemical safely.

Or, a chemical may be low in toxicity but present a hazard because it:

- Is normally used in a concentrated form.
- Is rapidly absorbed or inhaled.
- May be used frequently by untrained persons, who become exposed to it.

The terms LD50 and LC50 are used to express the toxicity of a pesticide. LD means lethal dose. LD50 is the dose that will kill 50 percent of a large population of test animals. LC means lethal concentration. LC50 is the concentration in the air or water that will kill 50 percent of the test animals.

Toxicity values can be expressed: (1) as an acute oral or acute dermal LD50, in terms of milligrams of toxicant per kilogram of body weight of the test animal (mg/kg); or (2) as an acute inhalation LC50, in terms of milligrams per liter of water, micrograms of mist or dust per liter of air, or parts per million by volume of gas or vapor (ppm).

The lower the LD50 or LC50 value, the more poisonous the pesticide. Acute dermal refers to a single dose applied directly to the skin (skin absorption). Acute inhalation refers to a single dose exposure through breathing or inhaling. The table on page 30 presents acute toxicity values for a few common pesticides.

Chronic poisoning is the result of prolonged exposure to small amounts of a pesticide. Acute LD50 values do not reflect the chronic toxicity of pesticides.

Comparative Pesticide Toxicity

(Acute oral LD50 mg/kg—rats)

Pesticide	Trade Name	LD50
INSECTICIDES		
aldicarb	Temik	0.93
parathion	Several brand names	3.6–13
zinphosmethyl	Guthion	11–13
diazinon	Spectracide	76–108
chlorpyrifos	Dursban, Lorsban	97–276
carbaryl	Sevin	500–850
malathion	Cythion	1,000–1,375
permethrin	Ambush, Pounce	4,000
temephos	Abate	8,600–13,000
HERBICIDES		
paraquat	Gramoxone	120
2,4-D	Several brand names	300–1,000
MSMA	Several brand names	1,800
atrazine	AAtrex	3,080
glyphosate	Roundup	4,320
simazine	Princep	5,000
picloram	Tordon	8,200
oryzalin	Surflan	10,000
amitrol	Amizol	24,600
FUNGICIDES		
triphenyltin hydroxide	Du-Ter	108
chlorothalonil	Bravo	1,000
triadimefon	Bayleton	1,000
benomyl	Benlate	10,000
PCNB	Terraclor	15,000
RODENTICIDES		
diphacinone	Diphacin	1.8–2.9
warfarin	Several brand names	3
zinc phosphide	ZP, Zinc-Tox	46
Common Substances For Comparison		LD50
table salt		3,320
gasoline		150
caffeine		200
baking soda		3,500

How Pesticides Enter The Body

A pesticide can enter the body through three common routes: (1) absorption through the skin (dermal); (2) absorption through the mouth and stomach (oral); and (3) absorption through the lungs (inhalation). Penetration through the eyes and irritation of the skin are special categories of dermal exposure.

Dermal

This is the most common route of pesticide exposure for pesticide applicators. Generally, dermal exposure can be caused by accidentally spilling or spraying a pesticide directly on the skin, by wearing clothing on which a pesticide has been spilled, or by drift of pesticides applied under windy conditions.

In general, wettable powders, dusts, and granular pesticides are not as readily absorbed through the skin and

other body tissues as are the liquid formulations such as emulsifiable concentrates. Emulsifiable concentrates contain a high percentage of the active ingredient in a relatively small amount of solvent. The solvents are readily absorbed through the skin.

If you have repeated or prolonged exposure to pesticides, take all precautions to avoid personal contamination. Wear protective clothing and safety devices prescribed by the manufacturer, and follow recommended procedures for mixing and applying the chemicals.

Oral

This type of exposure results from accidentally getting a pesticide in your mouth. When working with pesticides, wash thoroughly before eating, drinking, smoking, or using the toilet. Food and beverages should not be exposed to pesticides. To avoid the accidental drinking of a pesticide by children or other uninformed persons, do not store pesticides in anything (such as soft drink bottles) other than the original containers.

Inhalation

Pesticide absorption through the lungs is the most rapid and efficient route by which pesticides enter the body. Applicators are commonly exposed to pesticides through inhalation. Vapors and very fine particles represent the most serious potential for inhalation exposure. Respirators protect against inhaling chemicals. They should be worn when handling or applying highly toxic pesticides. The label will indicate if a respirator is necessary.

Safe Use Precautions

Most parts of your job may involve some risk of pesticide injury: hauling pesticides; storage; mixing; calibrating equipment; loading, applying, repairing equipment; working in pesticide-treated crops and buildings; cleaning up spills; and cleaning protective clothing and equipment. Some of these things are done indoors, many outdoors. Each one requires some safety measures to prevent harm to people, animals, and plants as well as to soil and water outside the target area. You can prevent harm from pesticides if you follow safety precautions and use common sense. Here are the minimum safety steps you should take.

Before You Buy A Pesticide

The first and most important step in choosing a pesticide is to know what pest you need to control. Then find out which pesticides will control it. You may have a choice of several. You may need help to guide you. Common sources of information are the Alabama Cooperative Extension Service, most agricultural schools, the U.S. Department of Agriculture, and pesticide manufacturers and dealers.

At The Time Of Purchase

Read the label of the pesticide you intend to buy to find out: restrictions on use, if this is the correct chemical for your problem, if the product can be used safely under your

conditions, environmental precautions needed, if the formulation and amount of active ingredient are right for your job, if you have the right equipment to apply the pesticide, if you have the right protective clothing and equipment, and how much pesticide you need.

Transportation Of Pesticides

You are responsible for the safe transport of your pesticide. Carelessness in moving pesticides can result in broken containers, spills, and contamination. Never carry pesticides inside your car or truck cab. Spills on seat covers are very hard to remove. The pesticide could even spill on you or your riders. The safest way to carry pesticides is in the back of a truck. Place the containers so they cannot shift, roll, or bounce around. Fasten down all containers to prevent breakage and spillage. Keep pesticides away from food, feed, and passengers. Pesticides should be in a correctly labeled package. Keep paper and cardboard packages dry. If any pesticide is spilled in or from the vehicle, clean it up right away. Use correct clean-up procedures. Do not leave unlocked pesticides unattended. Never allow children to ride on or near the pesticides. You are responsible if accidents occur.

Before You Apply The Pesticide

Read the label again to find out: the protective equipment needed to handle the pesticide, the specific warnings and first aid measures, what it can be mixed with, how to mix it, how much to use, safety measures, when to apply to control the pest and to meet residue tolerances, how to apply it, the rate of application, and special instructions.

Be sure plenty of liquid detergent and water are nearby for emergencies or clean-up. Check the label to be sure you have the necessary clothing and equipment. Choose a time when weather conditions are right. Choose the safest, most effective pesticide available. Always be sure the intended use is on the label.

Mixing And Loading Pesticides

Keep livestock, pets, and people out of the mixing and loading area. Do not work alone, especially at night. Work outdoors. Choose a place with good light and ventilation. Do not mix or load pesticides indoors or at night unless there is good lighting and ventilation. Before handling a pesticide container, put on the correct protective clothing and equipment. Each time you use a pesticide, read the directions for mixing before you open the container. This is essential. Directions, including amounts and methods, are often changed. Do not tear paper containers to open them. Use a sharp knife. Clean the knife afterwards, and do not use it for other purposes. When taking a pesticide out of the container, keep the container and pesticide below eye level. This will help prevent a splash or spill on your goggles or protective clothing. Do the same thing when pouring or dumping any pesticide.

If you splash or spill a pesticide while mixing or loading, stop right away. Remove contaminated clothing and wash thoroughly with detergent and water. Speed is essential. Clean up the spill.

When loading pesticides, stand so the wind blows

across your body from the right or left to avoid contaminating yourself. Plan your application so that you mix only what you will use. Using no more than the amounts called for will help prevent both injury to exposed plants and animals and illegal residues in foods. Do not combine pesticides unless the combination is called for on the label or you have consulted an authority. Always stand with your head well above the fill hole of the spray tank to keep pesticides from splashing in your face or eyes. To prevent spills, replace all pour caps and close containers after use.

Protective gear is especially important during mixing and filling because pesticide concentrates are more hazardous than diluted pesticides. Consider using rubber gloves, goggles, and a respirator when handling moderately toxic materials, even if the label doesn't call for them.

During Application

While you are applying pesticides, there are many safety precautions to follow. You are responsible for the protection of not only yourself but also other people, domestic animals, and the environment. You cannot afford to be careless.

Wear the correct protective clothing and equipment. To prevent spillage of chemicals, check all application equipment for leaking hoses, pumps, or connections and plugged, worn, or dripping nozzles. Use water to correctly calibrate spray equipment before using it. Before starting a field application, clear all livestock and people from the area to be treated.

Avoid Exposure

Do not work in drift, spray, or runoff unless you are properly protected. Do not wipe your hands on your clothing if chemicals have been spilled on your gloves. This will contaminate your clothing and may soak through to your skin. Do not blow out clogged hoses, nozzles, or lines with your mouth. Never eat, drink, smoke, or use the toilet when handling pesticides; wash your hands and face thoroughly first. Even moderately toxic chemicals can poison you if you work with them day after day. Consider using protective equipment—especially a respirator—even if the label doesn't call for it.

Watch out for others, too. Supervise your employees and be sure they follow all safety precautions. Try to work in pairs when handling hazardous pesticides. Watch your buddy carefully for unusual behavior or actions. If you feel sick, don't try to finish the job. Get out of the area fast and get help.

Keep children, unauthorized persons, and pets out of the area to be sprayed. Do not let children or pets play around sprayers, dusters, filler tanks, storage areas, or old pesticide containers.

Use pesticides at the proper rates. Overdoses won't control any more pests but may injure human beings, crops, or wildlife. Overdoses are misuses.

Avoid Equipment Accidents

Your application equipment can help you use pesticides safely. But poor maintenance and careless use can add to the hazard.

Be sure there are no leaks in the pump or tank. Check for leaky hose connections and worn spots in hoses that could burst and splash you or others with poisonous spray. If belts, pulleys, or drive chains are exposed, put guards around them so that no one can be injured. The spray tank should have a tight lid so that neither you nor others will be splashed and so that spray materials will not leak onto the ground.

Stay with the machine when the tank is being filled. A tank that is not watched often runs over and causes a pesticide spill on the ground or into a stream.

If you are working at the end of the spray hose some distance from your equipment, have someone near the sprayer so that children or others will not get caught in or injured by the machinery. The machinery should be shut down if you find it necessary to adjust or repair any moving parts. If nozzles, hoses, or lines clog, do not blow them out with your mouth. Even dilute spray mixtures can be toxic.

After Application—Clean-up

Safety and caution do not end with the application of the chemical. Proper clean-up and safety measures are still necessary. Complete one job entirely before going on to the next.

Mixing, loading, and application equipment must be cleaned as soon as you finish using it. Clean both the inside and outside, including nozzles. Only trained persons should do this job. They should wear correct protective clothing.

Sometimes you may need to steam-clean equipment or use special cleaning agents. In other cases, hot water and detergent may be enough. Equipment sometimes must be repaired before it is completely cleaned. Warn the person doing the repairs of the possible hazards of the chemical.

Have a special area for cleaning. It is best for the area to have a wash rack or concrete apron with a good sump to catch all contaminated wash water and pesticides. Dispose of sump wastes by burning or burial as you would excess pesticides. Keep drainage out of water supplies and streams.

Take a shower at the end of each day. Wash your body and scalp thoroughly with liquid detergent and water. Also, check your fingernails. Work clothing should be changed daily. If your clothes were exposed to pesticides, place them away from other clothes. Keep them well away from the family laundry. Do not allow children to play in the contaminated clothing. The pesticides on your work clothes could harm other people who touch them. Warn the person who will be washing your work clothes of possible dangers. Do not allow the clothes to be washed in streams or ponds. The pesticide could contaminate the water and cause fish kills.

Protective Clothing And Equipment

Pesticides can enter the body in many ways. The main ones are: getting the pesticide on your skin, inhaling it, and swallowing it. To prevent contamination, you must wear protective clothing and equipment. No safety recommendations can cover all situations. Your common sense

should tell you to use more protection as the hazard increases.

The need for protective clothing depends on the pesticide being handled. High toxicity is not the only factor; some others are formulation, application equipment, and degree of exposure. The label will tell the kind of protection needed for the pesticide being used.

Body Coverings

Any time you handle pesticides, you should wear at least a long-sleeved shirt and long-legged trousers or a coverall made of closely woven fabric.

Most applicators who regularly apply pesticides wear either a company uniform, coveralls, or some other type of protective clothing. Wear trousers outside of the boots to keep pesticides from getting inside. If you change into special spray clothes, be sure your "street" clothes are kept well away from the pesticides. Do not hang them in the storage or mixing area.

For ordinary application of highly toxic chemicals, wear clean, dry coveralls which cover your entire body from wrists to ankles. When handling pesticide concentrates or very toxic materials, you should also wear a liquid-proof raincoat or apron. If you (or your helper) will be in a mist or spray or if your coverall will be wet through for any reason, wear a liquid-proof suit. If heavy rubber rainsuits will be too hot, try the new lightweight liquid-proof suits. Wash your clothes with a detergent and water after every use.

Gloves

Always wear unlined, elbow-length neoprene or natural rubber gloves when handling organophosphates, carbamates, or other chemicals with "Danger" or "Warning" labels. However, some fumigants are readily absorbed by neoprene. The label will tell you what kind of gloves to use. Elbow-length gloves will protect your wrists and prevent pesticides from running down your sleeves into your gloves. Be sure your sleeves are *outside* your gloves.

Check closely for holes by filling the gloves with water and gently squeezing. Discard the gloves if any holes appear. Never use cotton, leather, or fabric-lined gloves for handling pesticides. These can be more hazardous than no protection at all because they hold the pesticide close to your skin for long periods of time. Also, the lining is hard to clean effectively. Follow the suggestions on the label when using other pesticides. When you are finished spraying, wash gloves with detergent and water *before* you remove them. Then you will not contaminate your hands.

Boots

When handling or applying highly toxic pesticides, wear lightweight, unlined neoprene or natural rubber boots which cover your ankles. These boots are not uncomfortably heavy or hot and will not absorb pesticides like canvas or leather footwear. Put your pants legs outside the boots so the pesticide cannot drain into them. The boots should be washed often and dried thoroughly inside and out to remove any pesticide residue. It is wise to keep two pairs of boots on hand in case of accidental

contamination. Some fumigants are readily absorbed by neoprene boots. Follow label instructions.

Goggles Or Face Shield

Wear tight-fitting goggles or a full face shield whenever the chemical could contact your eyes. Always wear them when you are pouring or mixing concentrates or working in a highly toxic spray or dust. Clean them often. Be careful of the headband; it is often made of a material which readily absorbs and holds chemicals. Have several spare headbands and change them often, or use a plastic, neoprene, or natural rubber strap. If possible, wear the strap under your head covering. Wear goggles or a face shield when there is any chance of getting pesticides in your eyes. Your eyes will absorb many pesticides. You can wear goggles alone or with a respirator.

Hat

Wear something to protect your head. A wide-brimmed, waterproof hat will protect your neck, eyes, mouth, and face. It should not have a cloth or leather sweatband. These sweatbands are hard to clean if chemicals get on them. Plastic "hard hats" with plastic sweatbands are good. They are waterproof and are cool in hot weather.

The hair and skin on your head and neck must be protected, too. Rubber or plastic rain hats, wide-brimmed hats, bill caps, and hard hats which can be washed are good. In cool weather, waterproof parkas with hoods and a bill cap are also good. Avoid cotton or felt hats because they absorb the pesticide.

Respirators

Respirators protect you from inhaling toxic chemicals. The label tells if a respirator is needed. They are especially necessary whenever you are handling concentrated, highly toxic pesticides. Always wear a respirator while mixing or filling highly toxic pesticides. If you will be exposed even to small amounts of toxic pesticides for a day or several days you should also wear a respirator.

The respiratory tract—lungs and other parts of the breathing system—is much more absorbent than skin. You must wear an approved respiratory device when the label directs you to do so. Follow the label instructions on respiratory protection. You probably need a respirator if you will be exposed to a pesticide for a long time, if the pesticide you are using is highly toxic, or if you are working in an enclosed area.

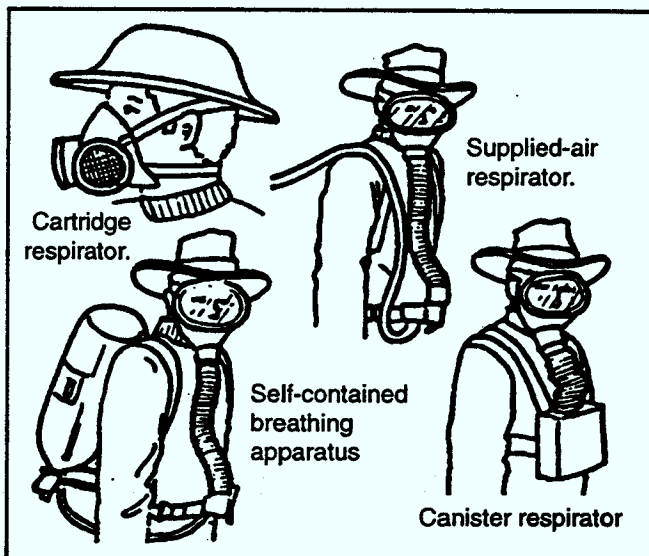
Surgical Masks

Surgical masks are *not* respirators. They do afford mouth and lung protection and are occasionally worn when mixing or using low toxicity pesticides or dry formulations. They are effective for removing, or greatly reducing, the amount of particulate matter inhaled. They are not suggested for use around fine mists and do nothing to prevent vapor inhalation.

Cartridge Respirators

Cartridge respirators are usually half-face masks which cover the nose and mouth only. They contain one or two

"cartridges" which filter the air you breathe by absorbing toxic fumes, vapors, and particles. To cover the eyes also, use a respirator that is combined with goggles or wear separate goggles. These respirators are used either for relatively short periods of exposure to concentrated chemicals or for a long period of exposure to low concentrations of toxic chemicals. The main limitation of this type of respirator is the short life of the absorbing material in the cartridge. Make sure the correct replacement cartridge is used.



Gas Masks (Canister Respirators)

Gas mask respirators cover the entire face and protect your eyes, nose, and mouth. They contain better filters and more absorbing material to cleanse the air than cartridge respirators. Gas masks are used when the applicator intends to be exposed to toxic fumes in heavy concentrations or for long periods of time. Gas masks usually protect the face better than cartridge types. Neither kind will protect you during fumigation or when the oxygen supply is low, as in a silo.

Supplied-Air Respirators

These are respirators which cover the entire face. A separate air supply is used, not the air with pesticide vapors in it. They are used when the oxygen supply in the air is low, when the applicator will be exposed to high concentrations of highly toxic pesticides in enclosed areas (such as during fumigation), and when your work can be done close to a supply of clean air. Clean air is pumped through a hose to the face mask.

Self-Contained Breathing Apparatus

You should wear this kind of respirator under the same conditions as the supplied-air respirator. It does about the same thing. The difference is that you carry cylinders of air or oxygen with you, usually on your back. The portable cylinder lets you move more freely and over a wider area than you can with a supplied-air respirator.

Respirator Maintenance

Specific types of cartridges and canisters protect against specific chemical gases and vapors. Be sure you choose one made for the pesticides you are using. Use only

those approved by the National Institute for Occupational Safety and Health (NIOSH), or the Mining Enforcement and Safety Administration (MESA).

The respirator must fit the face well. It should be worn tightly enough to form a seal all around your face. Do not wear the headband too tightly; headaches and/or dizziness may result. Long sideburns, full beards, or glasses may prevent a good seal. Read the manufacturer's instructions on the use and care of any respirator and its parts before you use it.

Check the filter (the cloth-like outer layer) on your respirator often. Replace it when it looks dirty or if breathing becomes difficult. The useful life of a cartridge or canister depends on the amount of absorbent material, the concentration of contaminants in the air, the breathing rate of the wearer, and the temperature and humidity. Cartridges and canisters should be changed at least after every 8 hours of use. If you notice a pesticide odor, first check to be sure the respirator is sealed on your face. If the odor persists, change the cartridge or canister immediately.

After each use, wash the face piece with detergent and warm water. Rinse thoroughly and wipe dry with clean cloth. Store the respirator, filters, canisters, and cartridges in a clean, dry place away from pesticides. A tightly closed plastic bag works well for storage.

How Pesticides Affect People

It is not known exactly how all pesticides poison the body, but some of the signs and symptoms of such poisoning are quite well known. These warnings (signs and symptoms) of the body in response to poisoning should be recognized by those who use pesticides.

Everyone is subject to various sicknesses. So although a person has been around pesticides, any signs or symptoms are not necessarily the result of pesticide poisoning. But, if they appear after possible contact with pesticides, contact a physician.

Be alert to the early stages of signs and symptoms of poisoning. If they do occur, you should immediately and completely remove the source of exposure to the chemical, such as contaminated clothing. This will help prevent additional exposure and will minimize injury. In some instances, early recognition of these warnings and immediate and complete removal of the source of exposure may save a life.

Kinds Of Poisoning

Acute poisoning occurs after a single exposure to a pesticide. *Chronic* poisoning occurs as a result of repeated exposures over a period of time.

Warn Your Doctor

Most medical doctors are not well informed about the symptoms and treatment of pesticide poisoning because they treat very few cases. Pesticide poisoning symptoms are similar to those of other illnesses and poisonings. You should tell your doctor which chemicals you use. Then he will learn the symptoms and treatment and have the antidotes on hand.

Signs And Symptoms Of Pesticide Poisoning

You should know what kinds of symptoms are caused by the pesticides you use. Also, know the conditions under which each one may make you sick.

There are two kinds of clues to pesticide poisoning. Some are feelings that only the persons who have been poisoned can notice—such as nausea or headache. These are symptoms. Others, like vomiting, also can be noticed by someone else. These are signs. So you should know what your own feelings might mean and what signs of poisoning to look for in your co-workers and others who may have been exposed.

All pesticides in the same chemical group cause the same kinds of symptoms. These symptoms may be mild or severe, depending on the pesticide and the amount absorbed. But the pattern of illness caused by one type of pesticide is always the same. Having some of the signs and symptoms does not always mean you have been poisoned. Other kinds of sickness may cause similar signs and symptoms. Headache and a feeling of being unwell, for example, may signal the start of many kinds of illness. It is the *pattern* of symptoms that makes it possible to tell one kind from another.

Get medical advice quickly if you or any of your fellow workers have unusual or unexplained symptoms starting at work or later the same day. If you suspect someone has been poisoned, do not leave that person alone. Do not let yourself or anyone else get dangerously sick before calling your physician or going to a hospital. It is better to be too cautious than too late. Take the container (or the label) of the pesticide to the physician. Do not carry the pesticide container in the passenger space of a car or truck.

Synthetic Organic Pesticides

Organophosphates—These pesticides injure the nervous system. The signs and symptoms go through stages. They normally occur in this order:

MILD POISONING

fatigue	too much sweating and
headache	salivation
dizziness	nausea and vomiting
blurred vision	stomach cramps or diarrhea

MODERATE POISONING

unable to walk	constriction of pupil of
weakness	eye
chest discomfort	earlier symptoms
muscle twitches	become more severe

SEVERE POISONING

unconsciousness	secretions from mouth
severe constriction	and nose
of pupil of eye	breathing difficulty
muscle twitches	death if not treated

Illness may be delayed a few hours. But if signs or symptoms start more than 12 hours after you were exposed to the pesticide, you probably have some other illness. Check with your physician to be sure.

Carbamates—There is a wide range of toxicity among carbamate pesticides. The only ones likely to make you ill on the job act almost like organophosphates. They produce

the same signs and symptoms if you are poisoned by them. The label will warn you of the danger.

Organochlorines—As a group organochlorines (chlorinated hydrocarbons) are safer than organophosphates and carbamates. However, some may prove hazardous to applicators. Early signs and symptoms of poisoning include headache, nausea, vomiting, general discomfort, and dizziness.

With more severe poisoning, convulsions follow. They may even appear without the warning symptoms. Coma may follow the convulsions. The person also may be unusually excited or irritable.

Nitrophenols and Phentachlorophenol—The signs and symptoms include:

SKIN EXPOSURE

redness	burning	blisters
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POISONING

headache	deep and fast breathing
nausea	fast beating of the
gastric distress	heart
restlessness	fever
hot feeling	ashen color
flushed skin	collapse
sweating	coma

Severe poisoning usually runs a rapid course. One usually dies or is almost well within 24 to 48 hours.

Fumigants and Solvents—Too much exposure to these compounds may make a person seem drunk. The signs and symptoms are:

poor coordination	confusion
slurred words	sleepiness

Repeated exposure to the fumigant methyl bromide has caused permanent internal injury without early signs or symptoms of poisoning. You can absorb a fatal dose of it before symptoms appear.

Inorganic Pesticides

Large single doses of most inorganic pesticides cause vomiting and stomach pain. The sign and symptoms depend on the mineral from which the pesticide is made.

Plant-Derived Pesticides

Some plant-derived pesticides are very toxic. Technical pyrethrum may cause allergic reactions. Some rotenone dusts irritate the respiratory tract. Nicotine is a fast-acting nerve poison about as dangerous as parathion. Some other plant-derived pesticides are strychnine, rotenone, and red squill.

Herbicide Poisoning

Some herbicides cause irritation of the skin, eyes, and mucous membranes when they come in contact. In addition, some cause poisoning when they are swallowed. Poisonings by some herbicides are relatively mild; particular chemicals, however, can cause severe illnesses and even death. Various herbicides do not all cause the same symptoms and signs of illness. Each chemical family (such as bipyridyl, nitrophenolic, and chlorophenolic compounds) attacks the human body in different ways.

The sickness may be mild or severe, depending on the pesticide and the amount absorbed. Patterns of illness caused by one family of pesticides are similar. Also, laboratory tests are often helpful in identifying herbicide poisoning.

Be aware of the general symptoms of herbicide poisoning. The most common signs and symptoms from ingesting a herbicide are irritation of the mouth and throat, vomiting, chest and abdominal pain, and diarrhea. Skin and eye exposure usually result in irritation. Inhalation can cause coughing, dizziness, nose and throat irritation, and sometimes nosebleed.

All of these symptoms will not necessarily occur after excessive exposure. There will be differences between individuals, the amount of herbicide, and route of entry (oral, dermal, respiratory, or a combination). Certain herbicides cause symptoms peculiar to that chemical; for example, swallowing paraquat may cause a lung disease that usually leads to death.

First Aid

Call A Doctor

First aid is just that. It is the initial effort to help a victim while medical help is on the way. Essential in any poisoning emergency is to get professional care for the victim as promptly as possible, either by transporting the victim to an emergency care facility or by calling a physician. When professional help is not available, you must see that the victim continues to breathe and is not further exposed before leaving to make your phone call. Always save the pesticide and the label for the doctor's inspection.

First Aid Procedures

Read the directions in the "Statement of Practical Treatment" on each label. These instructions can save your life and the lives of your employees.

If you get a pesticide on your skin, remove the pesticide as quickly as possible. Remove all contaminated clothing. Prompt washing may prevent sickness even when the spill is very large. Don't forget your hair and fingernails. Water-wettable powders or suspensions are easy to remove with plain water. So are most emulsifiable concentrates and emulsions. Solutions of pesticides in petroleum oil or other solvents are harder to remove without soap or a detergent. Detergents work better. Washrooms and emergency field washing facilities should have detergents rather than plain soap.

If you inhale a pesticide, get to fresh air right away. If you splash a pesticide into your mouth or swallow it, rinse your mouth with plenty of water. Go or have someone take you to a physician immediately. It is sometimes dangerous to cause vomiting; follow label directions.

Poison On The Skin

- The faster the poison is washed off the patient, the less the injury that will result.
- Drench skin and clothing with water (shower, hose, faucet, pond).
- Remove contaminated clothing.

- Clean skin and hair thoroughly with soap and water. Liquid detergents are better than soap.

- Dry and wrap victim in blanket, if the person appears ill.

- **WARNING:** Do not allow the pesticide to get on you while you are helping the victim.

Chemical Burns On The Skin

- Wash with large quantities of running water.
- Remove contaminated clothing.
- Immediately cover loosely with a clean, soft cloth.
- Do not apply ointments, greases, powders, or other agents.

Poison In The Eye

- It is most important to wash the chemical from the eye as quickly but as gently as possible.

- Hold eyelids open; wash eyes with a gentle stream of clean, running water. Tap water is satisfactory. Immediate flushing of the eye may save the victim's eyesight.

- Continue washing 15 minutes or more.
- Do not use chemicals or drugs in wash water. They may increase the extent of the injury.

Inhaled Poisons (Dusts, Vapors, Gases)

- If the victim is in an enclosed space, do not go in to get the person without an supplied-air respirator.

- Carry the victim (do not let the person walk) to fresh air immediately.

- Open all doors and windows.
- Loosen all tight clothing.
- Apply artificial respiration if breathing has stopped or is irregular.

- Keep the patient as quiet as possible.
- If the patient is convulsing, watch his or her breathing and protect the person from falling and striking his or her head. Keep the chin up so the air passage will remain free for breathing.

- Prevent chilling (wrap the victim in blankets) but don't overheat.

- Do not give alcohol in any form.

Ingested Pesticide

The most important choice you have to make when aiding a person who has swallowed a pesticide is whether to make the victim vomit. The decision must be made quickly and accurately; the victim's life may depend on it. Usually it is best to get rid of the swallowed poison fast—but read the label first.

Never induce vomiting if the victim is unconscious or in convulsions. The victim could choke to death on the vomitus.

Never induce vomiting if the victim has swallowed a corrosive poison. Find out what poison the person has ingested. A corrosive poison is a strong acid or alkali. The victim will complain of severe pain and have signs of severe mouth and throat burns. A corrosive poison will burn the throat and mouth as severely coming up as it did going down. It may also get into the lungs and cause severe damage there.

Never induce vomiting if the person has swallowed petroleum products (such as kerosene, gasoline, oil). Most pesticides in liquid formulations are dissolved in petroleum products. The words "emulsifiable concentrate" or "oil solution" on the pesticide label are signs NOT to induce vomiting in the person who has swallowed the concentrates. Concentrated petroleum products (like corrosive poisons) cause severe burns. They will burn as severely when vomited up. They will also severely damage the lungs. If the victim has swallowed a *dilute* form of these formulations, vomiting should be forced immediately.

If the victim has swallowed a highly toxic pesticide dissolved in petroleum products, consult a physician immediately. He or she will advise you whether or not to induce vomiting.

Do not waste a lot of time inducing vomiting. Use it only as first aid until you can get the victim to a hospital. Make sure the victim is lying face down or kneeling forward while retching or vomiting. Do not lay the person on his or her back because vomitus can enter the lungs and do more damage.

Induce vomiting by putting your finger or the blunt end of a spoon at the back of the throat. Do not use anything which is sharp or pointed. A glass of soapy water will also cause the victim to vomit.

Collect some of the vomitus for the doctor. He or she may need it for chemical tests.

The best first aid is to dilute the poison as quickly as possible and to neutralize the acid or alkali causing the burns. It is very important that the victim get to a hospital without delay.

For acids or alkali (base), give the patient water or, preferably, milk. Give 1 to 2 cups for victims under 5 years and up to a quart for those over 5 years. Milk is better than water because it dilutes and helps neutralize the poison. Water only dilutes the poison.

Poison Control Centers

Poison Control Centers have been established to give pertinent information on all types of poisonings, including pesticides. Keep the phone number of the nearest Poison Control Center posted near your phone. Your doctor should also have the number.

Alabama Poison Control Centers

City	Name And Address	Phone	Director
Birmingham	Regional Poison Control Center of The Children's Hospital of Alabama* 1600 6th Avenue South, 35233	1-800-292-6678**	Bill King, Pharm.D.
Tuscaloosa	Alabama Poison Center* 408 Paul Bryant Drive, 35401	1-800-462-0800**	Perry Lovely, M.D.

*Designated as Poison Control Center by State Committee of Public Health

**Toll-free from anywhere in Alabama.

Chapter 5

Test

1. Distinguish between acute (A) and chronic (C) poisoning by placing an A or C in front of the correct statement representing each.

- ___ a. Poisoning which occurs after a single exposure to a pesticide.
- ___ b. Poisoning which occurs as a result of repeated exposures to pesticides over a period of time.

2. Name three ways pesticides enter the body.

- a. _____
- b. _____
- c. _____

3. Name four factors that determine the types of protective clothing and protective equipment needed.

- a. _____
- b. _____
- c. _____
- d. _____

4. Name three safety precautions used while mixing and handling concentrated pesticides.

- a. _____
- b. _____
- c. _____

5. Name four ways to prevent exposure during application.

- a. _____
- b. _____
- c. _____
- d. _____

6. Name personal safety rules to follow in cleaning up after application.

- a. _____
- b. _____
- c. _____
- d. _____

7. List factors to consider when using coveralls as protective clothing.

- a. _____
- b. _____
- c. _____
- d. _____

8. List factors to consider when using gloves as protective clothing.

- a. _____
- b. _____
- c. _____
- d. _____

9. List factors to consider when using boots as protective clothing.

- a. _____
- b. _____
- c. _____
- d. _____

10. List factors to consider when using goggles and face shield as protective equipment.

- a. _____
- b. _____
- c. _____
- d. _____

11. List two factors to consider when choosing head and neck covering for protection.

- a. _____
- b. _____

12. Match the terms on the right to the correct definitions on the left by placing the appropriate numbers in the blanks provided.

- | | |
|---|---------------------|
| _____ a. Metal or plastic container filled with absorbent materials to filter fumes and vapors from the air. | 1. Respirator |
| _____ b. Cylinder-shaped part of the respirator which absorbs fumes and vapors from the air. | 2. Reentry interval |
| _____ c. Face mask which filters out poisonous gases and particles. | 3. Canister |
| _____ d. Movement of droplets or particles of a pesticide by wind. | 4. Fumes |
| _____ e. Period of time between a pesticide application and when persons can safely go back into an area without wearing protective clothing and equipment. | 5. Face shield |
| _____ f. Synthetic rubber. | 6. Drift |
| _____ g. Not protected or shielded; contact with pesticides through mouth, lungs, or skin. | 7. Cartridge |
| _____ h. Piece of protective equipment used by pesticide applicator to protect face from exposure. | 8. Neoprene |
| _____ i. Unpleasant or irritating smoke, vapor, or gas. | 9. Exposure |

13. Describe the general symptoms of herbicide poisoning. _____

14. Match the terms on the right to the correct definitions on the left by placing the appropriate numbers in the blanks provided.

- | | |
|--|------------------------|
| _____ a. Treatment given by a doctor to reduce the effects of pesticide poisoning. | 1. Inhalation |
| _____ b. Through the mouth. | 2. Inhalation toxicity |
| _____ c. To take a pesticide or other material into a plant, animal, or the soil. | 3. LC50 |
| _____ d. How poisonous a pesticide is to a living organism. | 4. LD50 |
| _____ e. Poisoning which occurs after a single exposure to a pesticide. | 5. Oral |
| _____ f. Dose or amount of pesticide which would kill half a large number of test animals if eaten or absorbed through the skin. | 6. Signs and symptoms |
| _____ g. Poisoning which occurs as a result of repeated exposures to pesticides over a period of time. | 7. Toxicity |
| _____ h. Concentration of a pesticide in the air which would kill half of the test animals exposed to it. | 8. Antidote |
| _____ i. How poisonous a pesticide is to man or animals when breathed in through the lungs. | 9. Absorb |
| _____ j. How poisonous a pesticide is to man or animals when in contact with the skin. | 10. Dermal toxicity |
| _____ k. To take air into the lungs; to breathe in | 11. Acute poisoning |
| _____ l. First effort to help a victim while medical help is on the way. | 12. Chronic poisoning |
| _____ m. Warnings that something is wrong. | 13. First aid |

15. Name the basic first aid rules for the following types of poisoning.

a. Poison on skin:

b. Chemical burn:

c. Poison in eye:

d. Inhaled poison:

16. Check an accepted first aid measure to induce vomiting.

___ a. Raise victim's hands over head.

___ b. Put finger down throat.

___ c. Give glass of milk.

___ d. Strike victim between shoulders.

Chapter 6

Laws And Regulations

Objectives

After completing this unit, the trainee will:

- Know the basic provisions of FIFRA.
- Know the penalties for pesticide misuse.
- Know the federal regulations governing transportation of pesticides.
- Understand the terms *pesticide residue* and *tolerance*.
- Know the basic provisions of Alabama pesticide laws.
- Become familiar with the different types of pesticide registrations.

Federal Law

Federal Insecticide, Fungicide, And Rodenticide Act

In 1947, Congress passed the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) to regulate the marketing of pesticides. The law required federal registration of pesticides shipped across state lines and made it unlawful to sell, in interstate commerce, unregistered pesticides or substances that had been misbranded or adulterated. The law did not address itself to actual pesticide use, nor did it control pesticides manufactured and used within the same state.

Provisions

In 1972, Congress amended FIFRA in an attempt to deal with the growing problem of pesticide misuse. The following are some of the key regulatory provisions of the amended FIFRA:

- Extends federal regulations to cover all pesticides used in the United States instead of only those products shipped across state lines.
- Requires federal registration of all pesticides with EPA.
- Makes pesticide misuse unlawful.
- Gives EPA the ability to classify all pesticide products for either "general use" or "restricted use."
- Requires certification of applicators using "restricted use" pesticides as private or commercial applicators.
- Sets minimum standards for determining the competency of certified applicators.
- Provides stronger enforcement provisions and establishes penalties for violation of FIFRA.

Penalties For Misuse By Commercial Applicators

FIFRA makes provisions for both civil and criminal penalties for misuse by commercial applicators. Civil penalties cannot exceed \$5,000 for each offense. A hearing on charges will be afforded in the county or city of resi-

dency of the applicator charged. Commercial applicators convicted of violating FIFRA are guilty of a misdemeanor and are subject to a fine of up to \$25,000, one year in prison, or both. Commercial applicators are criminally liable for the acts of their employees.

Transportation Of Pesticides

Shipment of pesticides and other dangerous substances across state lines is regulated by the Federal Department of Transportation (DOT). DOT issues the rules for handling these materials.

DOT standards tell you which pesticides are dangerous to human beings and create a health hazard during transportation. If you ever haul pesticides between states, you should know that:

1. They must be in their original packages. Each package must meet DOT standards.
2. The vehicle must have a correct sign. Manufacturers must put the correct warning signs on each package.
3. The pesticides may not be hauled in the same vehicle with food products.
4. You must contact DOT right away after each accident when someone is killed, someone is injured badly enough to go to a hospital, or when damage is more than \$50,000.
5. You must tell DOT about all spills during shipment.

Residues And Tolerances

Pesticide that remains in or on raw farm products or processed foods is called a *residue*. EPA sets residue tolerances under regulations authorized by the Federal Food, Drug, and Cosmetic Act. A *tolerance* is the maximum concentration of pesticide allowed in food items. Tolerances are expressed in parts per million (ppm). One ppm equals one unit of pesticide for every million units of farm or food product. Using pounds as a measure, 50 ppm would be 50 pounds of pesticide in 1 million pounds of product. One pesticide may have a different tolerance on different products. It might be 50 ppm on grapes and 25 ppm on apples.

If too much residue is found on a farm or food product, the product may be seized or condemned.

Illegal pesticide residues can normally be avoided by following label directions as to rate and pre-harvest interval.

Aerial Application

Application of pesticides from airplanes is regulated by the Federal Aviation Administration (FAA). FAA judges the flying ability of pilots and the safety of their aircraft. FAA rules, too, say that an aerial applicator may not apply

any pesticide except as the label directs.

Noxious Weed Act

The USDA Plant Protection and Quarantine Programs, under the authority of the Organic Act of 1944, as amended, have the authority to survey, control, and take regulatory measures on plant pests. Under the Federal Noxious Weed Act of 1974, USDA has the responsibility to designate certain foreign weeds as noxious and to prevent the entry of these weeds into the United States. New infestations of noxious weeds may be quarantined and controlled or eradicated. A permit from USDA is required to import plants or plant products into this country. Another permit is required to move designated noxious weeds into and throughout the United States, whether by mail, freight, baggage, or on the person.

Endangered Species Act Of 1973

The Endangered Species act requires EPA to ensure that endangered species are protected from pesticides. Under this act, it is a federal offense to use any pesticide in a manner that results in the death of a member of an endangered species. Before making applications, you must determine that endangered species are not located immediately adjacent to the site to be treated. If you are not sure whether or not endangered species may be affected, you should contact the regional U.S. Fish and Wildlife Office or the State Fish and Game Office at 64 North Union Street, Montgomery, Alabama 36130.

Alabama Law

Alabama Pesticide Act Of 1971

The main purpose of the Alabama Pesticide Act of 1971 is to regulate the sale, distribution, transportation, and use of all pesticides, with special emphasis on certain highly toxic and persistent pesticides. The Act requires annual registration of pesticides with the Department of Agriculture and Industries. The law also requires licensing of dealers that sell "restricted use" pesticides and permits for applicators.

Any person who violates any provision of the Act shall be guilty of a misdemeanor and fined upon being found guilty according to the law. Also, injunctive procedures and seizures can be used to restrain anyone from violating the Act. The Commissioner of Agriculture has the authority to restrict certain areas or to limit application by limiting licensing or to prohibit the licensee from applying certain pesticides.

Custom Applicator Law

The Custom Applicator Law, administered under the Agricultural Chemistry Division of the Department of Agriculture and Industries, regulates the custom application of pesticides by aircraft and ground equipment. Briefly, this law requires licensing of custom applicators with the requirement that an examination be taken and passed. All equipment will have a special decal attached to it identifying it as belonging to a licensed applicator. The Custom Applicator Law covers the following categories of

commercial applicators:

1. Demonstration and Research
2. Agricultural Plant and Animal
3. Forest Pest Control
4. Right-of-Way Pest Control
5. Aquatic Pest Control
6. Regulatory Pest Control
7. Seed Treatment
8. Public Health Pest Control

Professional Service Law

The Professional Service Law, administered under the Plant Industries Division of the Department of Agriculture and Industries, requires licensing people involved in pest control work in and around structures, lawns, sods, and ornamental plants. Statutory requirements exist as to bonding and insurance coverage to protect both the licensee and the owner of the property being treated. The Professional Service Law covers the following categories of commercial applicators:

1. Ornamental and Turf Pest Control
2. Industrial, Institutional, and Household Pest Control
3. Fumigation Pest Control
4. Control of Wood-Destroying Organisms
5. Wood Preservation
6. Regulatory Pest Control

Registration Of Pesticides

Registration is the foundation of pesticide regulation. Each pesticide product that is shipped, distributed, or sold in the United States must bear an EPA approved label that is based on extensive investigations. In Alabama, each product must, in turn, be registered by the Alabama Department of Agriculture and Industries.

Requirements

To register a pesticide, the registrant must submit data to EPA showing that, when used as directed on the label, the pesticide will not have unreasonable adverse effects on humans, animals, crops, or the environment and that it will not result in illegal residues on food or feed. The amount of data required depends largely upon the perceived toxicity of the pesticide and the anticipated extent of exposure for humans and other non-target organisms from its intended uses.

In the past a registrant was required to submit data showing a pesticide product to be effective against those pests listed on the label. However, the Federal Pesticide Act of 1978 amended FIFRA to permit EPA to waive efficacy data requirements. Currently, EPA requires efficacy data only when (1) failure to control a pest would threaten human health, either directly or through disease transmission, or (2) when adding new uses for chemicals which have been identified as posing a risk of unreasonable adverse effects. EPA still has the option of taking appropriate action if any pesticide product proves to be ineffective.

The practical efficacy of a pesticide product depends on many diverse factors that vary among regions, states,

and localities and with time. In general, no one should construe the listing of a pest on a label to be a recommendation.

Product By Product

Although we speak of recommending or using pesticides such as parathion, maneb, or atrazine for specific uses, pesticide active ingredients are not registered as such for end use. Each pesticide product must be registered individually, and the instructions on the labeling cannot be legally extrapolated from one product to another, even though they might be of identical composition. In general, EPA has required the resubmission of supporting data or referral to supporting data in EPA files each time a new product was substantially changed, even though identical or similar products were already registered. This requirement has caused significant delays and expenses. These are being somewhat alleviated by conditional registration and should be more permanently alleviated by the development of registration standards. Conditional registration and registration standards are authorized by Federal Pesticide Act of 1978 amendments to FIFRA.

Conditional Registration

EPA is authorized to conditionally register a pesticide product under certain terms and conditions before all of the required data have been submitted or comprehensively reviewed by EPA. The submission or review of the required data is deferred until a later date. A conditional registration is more easily cancelled than a full registration should the registrant fail to submit the required data by the required date or if the data review is unfavorable. Conditional registration places no additional obligation on the pesticide user.

Conditional registration is granted in three situations: (1) products with use patterns and ingredients that are identical or similar to those of previously registered products; (2) new use patterns of previously registered products; (3) products containing new active ingredients.

Minor Uses

An average of 8 to 9 years and about \$15 million in research, development, and registration costs are required to bring a new pesticide active ingredient to the point of commercialization. Cost of production facility and other costs must still be added. Any additional use or change in use patterns involves additional expense. Pesticide producers will understandably not take unprofitable ventures merely because pesticide users need a product for a certain purpose. Yet the failure to fulfill that need may cause considerable loss to the pesticide user and the public.

Minor uses were defined in EPA's Minor Use Policy Statement as "those pesticide uses having insufficient market potential to economically justify the time and cost of developing the data needed to support registration, establish tolerances, and absorb product liability risks." The Policy Statement was approved by Deputy Assistant Administrator Edwin L. Johnson on September 30, 1980. This policy is designed to give priority attention to and

minimize regulatory burdens on registering and setting tolerances for minor use pesticides.

Interregional Research Project No. 4 (IR-4) is a cooperative effort among USDA, EPA, the State Experiment Stations, and the pesticide industry to accumulate the supportive data to register currently registered pesticides for minor uses. The minor use might involve the addition of a new crop or other label changes such as amounts, timing, and types of application. For a food or feed crop, IR-4's major task is to obtain a residue tolerance. This can be done only when there is already one or more existing tolerances for the pesticide.

Special Local Needs

Section 24(c) of FIFRA permits a state to register federally registered pesticides for some uses that are not listed on the label as registered by EPA. Such registrations are variously referred to as Special Local Need (SLN), 24(c), or state labels or registrations. A Special Local Need registration may be used only in the state that issues it. A Special Local Need label must be in the possession of the pesticide user at the time the pesticide is applied for the permitted use.

A state may register a pesticide for use on a food or feed crop only if there is a federal tolerance or exemption for that crop and EPA has not previously denied, disapproved, or cancelled registration for that use. The state may grant an SLN label for the new use of a product if other uses have been denied, disapproved, or cancelled only after consultation with appropriate EPA personnel. In Alabama, Special Local Need registrations are granted by the Alabama Department of Agriculture and Industries.

Experiment Uses

An Experiment Use Permit is granted by EPA or a state to permit more extensive application of an unregistered pesticide or use of a registered pesticide for an unregistered use to obtain supportive data for registration. If no tolerance or exemption from a tolerance exists for residues that can reasonably be expected on food or feed as a result of application, a temporary tolerance or exemption from a tolerance is also required.

Most researchers or their employees usually have no need for an experimental use permit. It is not required for substances applied in laboratory, greenhouse, and limited replicated field tests strictly for an experimental purpose. An experimental purpose is presumed for land use if the cumulative total is not more than 10 acres and if food or feed crops that might bear illegal residues are destroyed or fed only to experimental animals. An experimental purpose is presumed for water tests involving a surface area of one acre or less provided that the water will not be used for irrigation, drinking, or body contact recreational activities. The water must not contain or affect fish, shellfish, or other animals or plants that might be used for food or feed in the absence of a tolerance or exemption from a tolerance. EPA regulations state no limits on numbers of experimental animals but require that treated animals not be used for food or feed in the absence of a tolerance or exemption.

Emergency Exemptions From Registration

Emergency exemptions are used when an emergency pest situation arises for which no pesticide is registered. If both federal and state local needs registrations would take too long to enact, an emergency registration can be used. Known as "Section 18 exemptions" (Section 18 of FIFRA), these registrations are handled by the highest governor or federal agency chief. This provision allows the sale and use of a product for a nonregistered purpose for a specified period of time. Strict controls and record keeping are required for all these emergency uses. You must understand all of the special requirements and responsibilities involved whenever you use pesticides with emergency exemptions. The agency which has granted the emergency exemption will supply you with the necessary rates, safety precautions, and other vital information.

Restricted Use Pesticides

FIFRA as amended by the Federal Environmental Control Act of 1972 requires that each pesticide product be classified for general use or for restricted use on the basis of human and environmental hazards. The Environmental Protection Agency has the responsibility of classifying pesticides. Each state may restrict products in addition to those that are federally restricted. Labels of federally restricted pesticides must bear the following statement:

Restricted Use Pesticide

For retail sale to and use only by certified applicators or persons under direct supervision and only for those uses covered by the certified applicators' certification.

Retail dealers of restricted use pesticides in Alabama must be licensed by the Alabama Department of Agriculture and Industries. Dealers must pass a written examination once every three years as a part of the licensing requirements.

Use Consistent With Labeling

The terms *registration* and *labeling* are frequently used synonymously. When EPA or a state registers a pesticide product, it approves the label or labeling that must be affixed to or accompany that product. Although EPA or its predecessor, USDA, has registered pesticides for the 80 years since the Federal Insecticide Act of 1910 was enacted, the Federal government had essentially no other direct jurisdiction over pesticides until FIFRA was amended by the Federal Environmental Pesticide Control Act of 1972. One of the most consequential additions was section 12(a) (2) (g) which makes it unlawful to "use any registered pesticide in a manner inconsistent with its labeling."

EPA's interpretation of "inconsistent" has frequently interfered with the proper use of pesticides as well as being in apparent conflict with congressional intent. EPA has tended to interpret "inconsistent" as "failure to be identical."

The need to qualify Section 12(a) (2) (g) was recog-

nized in the Federal Pesticide Act of 1978 by defining certain exemptions. Uses which are now lawful because Congress exempted them from being inconsistent with the labeling include:

- Applying a pesticide at any dosage, concentration, or frequency less than that specified on the labeling.
- Applying a pesticide against any pest not specified on the labeling if the crop, animal, or site is listed and if the labeling does not prohibit such a use.
- Using any application method not prohibited on the labeling.
- Mixing a pesticide with fertilizer if not prohibited by the labeling.

Suspension Of Applicator Permits

The Commissioner of the Alabama Department of Agriculture and Industries may suspend, revoke, or (as may be necessary for protection of humans and the environment) modify any applicator permit when it becomes evident that the permit holder has:

1. Caused injury to humans and the environment by misuse of a pesticide.
2. Failed or refuses to keep true and accurate records of pesticide application as required.
3. Violated provisions of Alabama pesticide laws.
4. Used any pesticide in a manner inconsistent with its labeling.
5. Failed or refuses to comply with permit requirements, including renewal requirements.

Worker Protection Standards

Federal Worker Protection Standards are a part of the code of Federal Regulations, 40 CFR part 170, which requires protection of agricultural workers and handlers on farms and in forests, nurseries, and greenhouses. It also requires training, decontamination, notification, and emergency assistance of employees. Information has been added to the label to instruct both employer and employee as to personal protective equipment to wear and the restricted-reentry intervals. Further information on these standards is available in the EPA *How To Comply Manual* and from the pesticide labels. These standards became effective April 1994.

Civil Penalties

Civil Penalties were adopted on February 13, 1990, for various violations of Alabama pesticide laws. Maximum penalties were established, but it was not the intent that maximum amounts always be imposed. The decision to impose a penalty and its amount, up to the maximum allowed in these rules, is wholly within the discretion of the Commissioner of Agriculture and Industries. Some of the most important violations and maximum penalties are:

1. Maximum penalty for misuse of a restricted use pesticide is \$10,000.
2. Maximum penalty for misuse of a nonrestricted use pesticide is \$5,000.

3. Maximum penalty for a violation or any prohibited or unlawful act as described in Sec. 2-27-14, Code of Alabama (1975), is \$5,000.

4. Maximum penalty for operating without a license is \$5,000.

5. Maximum penalty for failure to keep books and records is \$1,000.

6. Maximum penalty for a proven violation not specified in Chapters 27 and 28 of Title 2, Code of Alabama (1975), is \$2,000.

7. Maximum penalties for violations of departmental orders are:

- A violation of a suspension or stop sale order is 5,000.

- A violation of an official written order after a hearing is \$2,000.

Provision is also made for the stacking of penalties. A penalty may be increased 100 percent if there is a proven subsequent violation of the same offense committed by the same person within 12 months of the first violation. If a subsequent violation occurs more than 12 months but less than 24 months after the first violation, the penalty may be increased by 50 percent. The maximum penalty may be increased by 25 percent if the subsequent violation occurs more than 24 months but less than 36 months after the first violation. No increase of penalties is allowed for subsequent violations occurring more than 36 months after the first violation.

Chapter 6

Test

1. What does FIFRA stand for?

2. List five provisions of FIFRA.

- _____
- _____
- _____
- _____
- _____

3. When must you notify the Department of Transportation of a pesticide spill?

4. Mark the following True (T) or False (F).

- _____ a. The maximum penalty for commercial applicators convicted of violating FIFRA is a \$25,000 fine and one year in prison.
- _____ b. A tolerance is the residue that remains on raw farm products.
- _____ c. Alabama Law requires licensing of dealers that sell "restricted use" pesticides.
- _____ d. The Alabama Custom Applicator Law requires licensing of applicators involved in pest control in and around structures, lawns, sods, and ornamental plants.
- _____ e. The Commissioner of Agriculture has the authority to limit licensing of applicators or to prohibit the licensee from applying certain pesticides.

5. What federal agency has the responsibility for registering pesticides?

6. What is a 24(c) registration?

7. Who issues 24(c) registrations in Alabama?

8. What is a Section 18 registration?

Chapter 7

Pesticide Disposal And Storage

Objectives

After completing this unit, the trainee will:

- Match technical terms associated with disposal and storage to their correct definitions.
- Identify and describe the proper methods for the disposal of excess pesticides and their containers.
- Describe the physical characteristics of a safe pesticide storage area.
- Explain what procedures should be followed to effectively handle pesticide spills.
- Describe how to properly arrange pesticide containers within the storage area.

Pesticide Disposal

Disposal of pesticides and their containers can be a problem. They should be returned to the manufacturer whenever possible. Otherwise, you must choose the method which is best for you and still protects others and the environment. Federal and state laws may require that you use certain methods when disposing of specific pesticides.

Surplus Pesticides

There are several ways in which you may end up with surplus pesticides. The government may cancel registration on a chemical, or its use may no longer be effective. You may buy more pesticide than you really need, or you may have some left in the tank after a job is done. You may have contaminated water left over after cleaning operations, spills, or rinsing. The pesticide may have lost its strength in storage, the container may be damaged, or the label may be missing.

Sometimes you cannot avoid having surplus pesticides. However, there are ways to cut down on pesticide surplus. Always check to be sure the pesticide is fully registered and is effective against the pest before you buy it. Estimate your needs and buy only what you need for one year. This will reduce carryover and the chance of spills, damaged containers, and loss of strength of the pesticide.

Avoid mixing the pesticide in the tank until after you have checked out a job. Then you are not faced with the disposal of the wrong pesticide for the problem. Mix only enough pesticide for the job so that you end up with an empty tank or hopper. Preventing pesticide surplus is the best way to take care of your disposal problem.

Empty Pesticide Containers

"Empty" pesticide containers are not really empty. They still contain small amounts of pesticide even after they have been rinsed out properly. Never toss them into

streams, ponds, fields, or empty buildings. Be able to account for every container you used for a job. Never give them to children to play with or allow uninformed persons to have them for any use. Dispose of all your pesticide containers carefully and properly.

To prepare containers for disposal:

1. Empty the container into the tank. Let it drain an extra 30 seconds.
2. Fill it one-fifth to one-fourth full of water.
3. Replace the closure and rotate the container so the rinse reaches all the side surfaces.
4. Drain the rinse water from the container into the tank. Let the container drain for 30 seconds after emptying.
5. Repeat steps 2 through 4 at least two more times for a total of three rinses.

Remember to empty each rinse solution into the tank.

The EPA recommendations divide containers into three groups. They tell you how to dispose of each kind.

GROUP I CONTAINERS—These are containers which will burn and which held organic or metallo-organic pesticides, but no organic mercury, lead, cadmium, or arsenic compounds.

The following are ways to dispose of them:

1. You may burn them in a special pesticide incinerator.
2. You may burn them in a specially designated landfill.
3. You may burn small numbers of them as directed by state and local regulations.
4. You may bury them singly in open fields. Bury them at least 18 inches below the surface. Be careful not to pollute surface or subsurface water.

GROUP II CONTAINERS—These are containers which will *not* burn and which held organic or metallo-organic pesticides, but not organic mercury, lead, cadmium, or arsenic compounds.

These are ways to dispose of them:

1. Rinse the containers three times as described above.
2. Many large containers in good shape can be reused by your supplier. Return them to the pesticide manufacturer or formulator or to a drum reconditioner.
3. You can send or take them to a place that will recycle them as scrap metal or dispose of them for you.
4. All rinsed containers may be crushed and buried in a sanitary landfill. Follow state and local standards.
5. If the containers have not been rinsed, bury them in a specially designated landfill.

GROUP III CONTAINERS—These include any containers which held organic mercury, lead, cadmium, arsenic, or inorganic pesticides.

These are ways to dispose of them:

1. Rinse them three times, as described above, and bury them in a sanitary landfill.
2. If they are not rinsed, bury them in a specially designated landfill.

Alabama Laws Affecting Pesticide And Pesticide Container Disposal

Disposal of excess pesticides and pesticide containers can be a real problem. There have been many cases of improper disposal which have resulted in contaminated water sources, killing of wildlife, and human health hazards. Anyone who fails to comply with the disposal regulations of the Alabama Department of Public Health may be punished under the law. Pesticide and pesticide container waste is, however, an inevitable part of any pest control. How can we safely and legally dispose of pesticide waste?

Pesticide waste may be classified as either hazardous waste or solid waste. Disposal instructions for hazardous waste can be obtained from your state or local Health Department office.

Pesticide containers that have been triple-rinsed are classified as solid waste. There are several options for disposal of solid waste. All approved sanitary landfills in Alabama are supposed to accept triple-rinsed containers.

Following written approval by the local Health Department, solid waste may be buried on your own land. Liquid-pesticide containers should be rinsed, punctured, and crushed before being buried. Certain conditions must be met in order to bury on your own land:

1. Waste must be covered with six inches or more of compacted earth each time the disposal site is used.
2. The disposal site should be located so as not to be subject to washing away by surface water drainage, flooding, or washout or to pose a potential contamination source for surface water and ground water.
3. The disposal site must be more than 100 feet from potable (suitable for drinking) water wells or waters. The disposal site should be located down gradient from existing or proposed potable water wells to minimize the possibility of contamination.
4. The location and operation of the disposal site must not cause a nuisance or health hazard. Private disposal sites are subject to periodic on-site inspection. Contact your local Health Department or Air Pollution Control Board about laws governing the burning, on your own land, of bags which contained dry formulations of pesticides.

Another possibility that should be looked into is the sale of empty drums or barrels to cooperage firms (barrel reclaimers). This is probably the best way to dispose of 55-gallon drums. Because of the relatively small quantity of drums used by an individual farm, several individuals or a community may pool their empty barrels at a central location. In this way, there may be sufficient numbers to warrant pick-up by cooperage firms. Also, some chemical companies are now selling liquid pesticides in containers which can be refilled. Ask your pesticide dealer about these products and take advantage of recyclable containers if possible.

Pesticide Storage

The label will tell you how to store the product. As soon as pesticides arrive, correctly store them in a locked and posted place. Children and other untrained persons should not be able to get to them. The storage place should keep the pesticides dry, cool, and out of direct sunlight. It should have enough insulation to keep the chemicals from freezing or overheating.

The storage place should have fire-resistant construction including a cement floor, an exhaust fan for ventilation, good lighting, and a lock on the door. Keep the door locked when the building is not in use.

The storage building should be away from where people and animals live. This will prevent or minimize harm to them in case of fire.

Store all pesticides in the original containers. Do not store them near food, feed, seed, or animals. Check every container often for leaks or breaks. If one is damaged, transfer the contents to a container that has held exactly the same pesticide. Clean up any spills correctly. Keep an up-to-date inventory of the pesticides you have.

Choosing The Best Site

Whether you plan to build a new storage area or use existing buildings, you need to consider several points. The site should be in an area where flooding is unlikely. It should be downwind and downhill from sensitive areas such as houses, ponds, and play areas. The site should also be in a place where wind-blown pesticide dusts and particles would not cause problems. There should be no chance that runoff or drainage from the site could contaminate surface or underground waters.

Setting Up The Storage Area

Pesticides should be stored in a cool, dry, airy room or building which is fire-resistant. The storage area should be fenced in or at least locked tightly. Weatherproof warning signs should be hung over every door and window. These should say something like: DANGER—PESTICIDES. KEEP OUT.

Windows are good because fire hoses and other fire-fighting equipment can be used through them. They should, however, be barred so that children and other curious people cannot get in.

A drainage system should be built to collect any runoff water. Pesticides which may be in tank rinsings, spills, seepage from the storage, and heavy runoff from fire-fighting or floods must be controlled. Otherwise, they may contaminate surface or underground water. Dikes, collecting pools, and washing slabs with sumps would provide a proper drainage system. All the collected runoff water should be treated as a surplus pesticide and disposed of properly.

A good supply of liquid detergent or hand cleanser and water is a must in a storage area. It's convenient for filling tanks, cleaning off equipment, and for you and your help to clean up with. It's also quick first aid in a poisoning emergency.

Absorptive clay, activated charcoal, vermiculite, pet litter, or sawdust should be readily available at the storage

site to soak up spills and leaks. Hydrated lime and sodium hypochlorite (Clorox or other bleach) should also be on hand to neutralize the pesticide in an emergency. A shovel, broom, dust pan, sealable container for sweepings, and fire extinguisher also must be in any storage area.

Arranging Your Storage Area

A pesticide storage area, whether it is a room or whole building, should be used only for pesticides and pesticide equipment. Never store or use food, drinks, silverware, tobacco, or smoking equipment in a storage or loading area. Livestock feed, living plants, and seeds should not be stored with or below pesticides either.

AVOID HOT PLACES—Glass and metal containers of liquid pesticides should be stored where they are not in the sun or near other sources of heat such as steam pipes. Heat will cause the liquid to expand so that the contents will be under pressure. When the container is opened, the pesticide may splash out on you. No pesticides should be allowed to become overheated. Some formulations will catch on fire if they get too hot. Others lose their strength and break down when they are exposed to heat or sunlight.

ORGANIZE STORAGE—Herbicides should be stored in a special place apart from other pesticides. Some herbicides can vaporize (become a gas) and get into other pesticides nearby. When the contaminated pesticide is used, the herbicide vapors in it may injure or kill crops and sensitive plants.

All highly toxic pesticides should be stored together in a special area, too. You can take special precautions to keep from being exposed when working in that area. Also, you are less likely to use a highly toxic pesticide by accident.

A special area should be used for surplus pesticides and their containers being held for disposal. They should be grouped together according to how you plan to dispose of them and should be plainly labeled. This will help prevent mix-ups resulting in improper disposal and even accidental reuse.

Handling Pesticide Containers

Pesticide containers should be stored with the label in plain sight. They should be stored up off the floor, especially if they can be injured by dampness. Rigid containers should always be set in an upright position so they cannot spill easily. All containers should be placed in orderly rows with enough room to allow you and your helpers to walk between them.

Damaged Containers

All pesticide containers should be checked often for corrosion, leaks, loose caps, or bungs. You must correct these dangerous conditions immediately. Pesticides should be stored in their original containers, if possible. Other containers often are not properly labeled with dosages, uses, and safety precautions. If containers are damaged, however, you should put the pesticide in a sturdy container which can be sealed. Be sure to label the new container.

Sometimes you can take the label from the damaged container and firmly fasten it to the new container.

Unlabeled pesticides are worthless because you don't know what they are or how to use them. They should be treated as surplus pesticides and properly disposed of.

Partly Empty Containers

These containers should be resealed and returned to storage. Opened containers of chlorates (sometimes used as herbicides) should not be stored. They can burst into flames at any time.

Improper Containers

Never store pesticides in anything used as a food or drink container. Pesticides stored in such things as soft drink bottles, fruit jars, or milk cartons are a common cause of accidental pesticide poisoning.

Pesticide Equipment Storage

All pesticide application equipment should be stored in a special area, too. Often the equipment is contaminated with pesticides. Never let children or uninformed people play on or around your machines. They could pick up a harmful dose of pesticide. Always wash your equipment carefully before you store it. Thoroughly rinse off the outside while it is parked in the special wash area.

Do not allow rinse water to get on the ground and into streams, ponds, or other sensitive areas. Collect it and hold it for proper disposal. All movable pesticide equipment should have a sign: "Danger—Pesticides" to warn people to stay away. Delivery trucks, nurse tanks, and other support equipment should be rinsed thoroughly and stored too.

Safety Measures

A little care and common sense can help prevent many accidents and emergencies in the storage area. You and your helpers should know the basic safety rules and follow them. You should also know what to do in case of any emergency. Make a list of safety procedures and post it in the storage area. Be sure that everyone follows the rules.

Protect Yourself And Others

- Do not allow children, pets, or uninformed persons into the storage area.
- Wear gloves when you are handling containers of pesticide concentrates. Use more protective clothing if the label says to.
- Do not put your fingers in your mouth or rub your eyes while you are working.
- Do not store or use tobacco, food, or drinks in areas where pesticides are present.
- Wash your hands carefully before eating, drinking, smoking, or using the toilet. Wash them as soon as you are finished handling the pesticides, too.
- Do not handle pesticide containers roughly; they are not meant to be thrown, dropped, or abused. Check all containers for leaks before you handle them.

Cleanup Of Pesticide Spills

Minor Spills

- Keep people away from spilled chemicals. Rope off the area and flag it to warn people. Do not leave unless someone is there to warn of the danger.
- If the pesticide was spilled on anyone, give the correct first aid.
- Confine the spill. If it starts to spread, dike it up with sand or soil.
- Use an absorbent material to soak up the spill. You can use soil, sawdust, or a special product made to do this. Shovel all contaminated material into a leakproof container for disposal. Dispose of it as you would excess pesticides. Do not hose down the area. This spreads the chemical.
- Put something on the spill to stop the chemical action. You may be able to use common household bleach or a solution of lye or ammonia. If you are not sure what to use, call the chemical manufacturer. Always work carefully. Do not hurry.
- Do not let anyone enter the area until the spill is all cleaned up.

Major Spills

- The cleanup job may be too big for you to handle. You may not be sure of what to do. In either case, keep people away, give first aid, and confine the spill. Then, call the manufacturer for help.
- The National Agricultural Chemicals Association has a Pesticide Safety Team Network. They can tell you what to do. Or, they can send a safety team to clean up the spill. You can call them toll-free any time at (800) 424-9300.
- If a major pesticide spill occurs on a highway, have someone call the highway patrol or the sheriff for help. Carry their phone numbers with you. Do not leave until responsible help arrives.
- Report all major spills by phone to your state pesticide regulatory agency. You may also need to notify other authorities.
- If the spill is on a state highway, call the highway patrol or the state highway department.
- If the spill is on a county road or a city street, call the county sheriff or city police.
- If food is contaminated, notify state or federal food and drug authorities or city, county, or state health officials.
- If water is contaminated, notify state health officials, regional, state, or federal water quality or water pollution authorities, and the state fish and game agency.

Chapter 7

Test

1. Describe ways to prevent pesticide surplus.

- _____
- _____
- _____
- _____

2. Describe steps to follow when rinsing pesticide containers.

- _____
- _____
- _____
- _____
- _____

3. Name three approved methods for disposing of "empty" pesticide containers.

- _____
- _____
- _____

4. List the factors to consider in selecting a pesticide storage site.

- _____
- _____
- _____
- _____

5. List five requirements of a good pesticide storage area.

- a. _____
- b. _____
- c. _____
- d. _____
- e. _____

6. List the factors to consider when arranging pesticide containers within the pesticide storage area.

- a. _____
- b. _____
- c. _____
- d. _____
- e. _____

7. List three safety procedures to follow to protect yourself and others from pesticide spills.

- a. _____
- b. _____
- c. _____

8. List several procedures to follow when minor pesticide spills occur.

- a. _____
- b. _____
- c. _____
- d. _____
- e. _____

9. List several procedures to follow when major pesticide spills occur.

- a. _____
- b. _____
- c. _____
- d. _____
- e. _____

Chapter 8

Record Keeping

Objectives

After completing this unit, the trainee will:

- List reasons for keeping records of pesticide use.
- List items of information needed for record keeping.

Introduction

Keeping records of pesticide usage is required by law. By federal regulations, records for each application of "restricted use" pesticides must be kept on file for a period of two years. Records can establish proof of proper use in damage suits, and they are helpful in finding the cause of error if an error was made. They can also provide information to trace residue and damage problems.

Records can also help you save money. They allow you to compare the results obtained from different pesticides. You can improve your pest control practices and efficiency, too. They help to reduce pesticide misuse. Careful records from year to year guide you in buying only the amounts of pesticides you will need. You can reduce winter inventory.

What Are The Requirements?

The more information you put on record, the more useful the records will be to you. Carry a notebook with you to the application site. All the information will be right there in front of you. Do not try to memorize all the necessary items. Fill in a standard form to be sure you get all the necessary data every time.

The following is a list of the information needed:

- Time of day and date of application
- Target pest(s)
- Equipment used
- Pesticide used:
 - Common name
 - Brand name
 - Formulation and percent of active ingredient
 - EPA registration numbers
 - Establishment and lot numbers (in case of cross-contamination or failure to control)
 - Total formulation added to tank or hopper
 - Amount of mixture used
 - Acres treated
- Additional comments:
 - Location
 - Weather
 - Applicator
 - Severity of infestation

On every record form there should be a space left for *Additional Comments*. Use this space to jot down information for your own personal use. This information can be used to improve your business either through better customer relations or by saving you money. Such records can also be helpful in liability cases.

The job is never finished until the paperwork is done.

Chapter 8

Test

1. List four reasons for keeping records.

- a. _____
- b. _____
- c. _____
- d. _____

2. List four items of information needed for record keeping.

- a. _____
- b. _____
- c. _____
- d. _____

Chapter 9

Ground Application Equipment And Equipment Calibration

Objectives

After completing this unit, the trainee will:

- Name factors to consider when choosing pesticide application equipment.
- Know how to control the amount of pesticide deposited on the target.
- Know the components of pesticide application equipment.
- List the uses for basic types of spray equipment.
- Know the spray patterns produced by various types of nozzles.
- Understand how to correctly calibrate pesticide application equipment.

Introduction

The ground equipment used in applying pesticides varies with the target pest, the site of application, the size of the job, and the formulation used. There are many different types of application equipment. They all have one requirement in common—they must deliver the pesticide uniformly over the target area at a known rate of delivery. Measurement and adjustment of the rate of delivery is called calibration.

Most applicators are already familiar with the performance of their application equipment. However, if you are buying new equipment, you will want to get a type designed for the bulk of work you intend to do. There are several sources of information available—the Alabama Cooperative Extension Service, other applicators experienced in the same line of work, and equipment manufacturers. Manufacturers can usually furnish complete performance data. Take full advantage of any charts, calibration aids, or other help that they can supply. Your equipment should be designed to do the job you want to do and be durable and convenient to fill, operate, and clean.

Sprayers

Usually, your spray equipment will already be set up to meet your needs. You can make minor changes in spray delivery by adjusting the speed or the pressure or by using different nozzle tips. Make routine checks of your sprayer to make sure that the nozzles are not worn and that they have uniform output, uniform spray patterns, and equal fan angles. Replace any nozzle tip having a flow rate of 5 percent more or less than the average for all nozzles.

High-Pressure Sprayers

High-pressure sprays (also called hydraulic sprayers) are designed to deliver large volumes of pesticide at high pressure. When fitted with the correct pressure regulators, they can also be used at low pressures. Applications are usually made at the rate of 100 or more gallons per acre. Even though very large tanks are used, they may need to be filled often.

Conventional high-pressure sprayers are particularly useful for applying pesticides to tall trees or dense brush. This type of sprayer is commonly used with an adjustable handgun and length of hose adequate for the situation. Because of their high pressure, these sprayers can give thorough coverage of the target vegetation, avoiding desirable plants. Even a sprayer with a small to medium-size pump can reach 20 to 30 feet vertically.

High-pressure sprayers can also be used with conventional or modified booms mounted on trucks.

Advantages: Well built; usually have mechanical agitation; last a long time even when using wettable powders.

Limitations: High cost; large amounts of water power and fuel needed; high tire loads; high pressure which makes a spray that drifts easily.

Low-Pressure Sprayers

Low-pressure sprayers are designed to deliver low to moderate volumes at 15 to 60 psi. They are useful in applying a variety of pesticides to many agricultural crops. There are several models designed to be mounted on tractors or carried on trucks. These are easily mounted and dismounted, relatively light in weight, and capable of operating in areas of limited accessibility.

When using a boom, have some way to protect the boom from damage if a tree or other obstacle is encountered. The most common boom is made in three sections—one rigid section in the middle of the machine and a folding section extending out on each side. These outer sections are hinged at their inner ends and are supported from the center of the machine by a rope or light chain. The height of the spray boom must be easily adjustable so the nozzles can deliver the chemical uniformly.

Advantages: Medium-size to large tanks; low cost; light weight; versatile.

Limitations: Low gallonage output which limits use when high volume is required; low pressure which limits pesticide penetration into dense foliage.

Truck-Mounted Sprayers (Swinglok™)

Truck-mounted equipment is sometimes used for spraying. This equipment is composed of a high-volume tank and a series of different nozzles, each delivering spray a different distance from the truck. Truck-mounted sprayers can be operated at high speeds (5 to 12 miles per hour) and therefore treat highway rights-of-way relatively quickly. Even distribution can be difficult if the sprayers are not properly calibrated and maintained.

Hand Sprayers

Compressed air and knapsack type sprayers, while small and of limited capacity, have uses in pest management. They are useful for making spot applications of herbicides, fungicides, and insecticides.

Advantages: Economical; easy to use, clean, and store.

Limitations: Frequent lack of good agitation and screening for wettable powders; useful for small areas only.

Sprayer Components

This section will describe some of the components of spray equipment used for pest control. Determine your needs; then use the right equipment for the right job.

Tanks

The tank should be large enough to avoid the need for frequent refilling. If your nozzle discharge is 10 gpm, a 1,000-gallon tank will last 100 minutes. But too large a tank is wasteful if it is seldom filled.

Tanks should have large openings for easy filling and cleaning. They should allow straining during filling and have mechanical or hydraulic agitation. The tank should be made of corrosion-resistant material such as stainless steel or glass-reinforced plastic. If made of mild steel, it should have protective plastic lining or coating. Stainless steel and fiberglass are considered the best tank materials because they resist corrosion, but they are expensive. You must weigh your need for durability against cost.

Every spray tank should have shut-off valves so that any liquid in your tank can be held there without leakage. The tank should have a good drain. The outlets should be sized to the pump capacity. If you use dual tanks, make sure the plumbing allows for agitation and adequate withdrawal rates in both tanks. All tanks should have a gauge to show the liquid level.

Flush out the tank, pump, lines, and nozzles after each day's use and each separate pesticide use. If switching to another pesticide where contamination must be prevented, wash out with detergent and water two or three times and then flush with water. Phenoxy herbicides such as 2,4-D are hard to remove. After using them, either follow the special cleaning procedures noted on the pesticide label or avoid using the same sprayer for any other product. Keep the tank clean inside and out. Tighten or repair all leaky tank seals or fittings. Make sure sight gauges can be read.

Agitators

Make sure your sprayer has enough agitation. If it does not, your pesticide application rate may vary greatly as the tank is emptied. Bypass agitation may be good enough for solutions and emulsions. Use a jet agitator or mechanical agitator for wettable powders. Mechanical agitation is the surest way to get good agitation. It is expensive initially and is harder to maintain. Hand sprayers must be shaken frequently.

The need for agitation depends on the formulation of the pesticide to be applied. Liquid concentrates, soluble powders, and emulsions require little agitation—usually the flow from the pressure regulator bypass is sufficient.

Wettable powder suspension, however, requires vigorous mechanical agitation to prevent settling out. Tanks with square corners require stronger agitation than tanks with rounded shapes.

There are two methods of agitating the spray material in the tank. *Mechanical agitation* is provided by paddles or propellers. *Hydraulic agitation* is provided by the return flow of excessive spray material from the high pressure side of the pump. If hydraulic agitation must be used to suspend wettable powders, a simple bypass line from the pressure relief valve is not enough.

Strainers (Filters)

Proper filtering of the pesticide solution protects the working parts of the sprayer and avoids time loss and misapplication due to clogged nozzle tips. Filtering should be progressive with the largest mesh screen in the suction line between the tank and the pump. Put a smaller mesh screen in the pressure line between the pump and the pressure regulator. Put the finest mesh screen nearest the nozzles.

Clean the screens after each use and replace them as they deteriorate. Strainers are your best defense against nozzle and pump wear and nozzle clogging. Use nozzle screens as large as nozzle sizes permit. Screen opening should be less than nozzle opening.

Strainers are used to reduce wear and prevent scale, rust flakes, and other foreign material from plugging the nozzle or other working parts of your sprayer. They should be installed in the suction line, high-pressure line, and in each nozzle body. If strainers are purchased as part of the nozzles, an additional strainer should be placed on the intake line.

Pumps

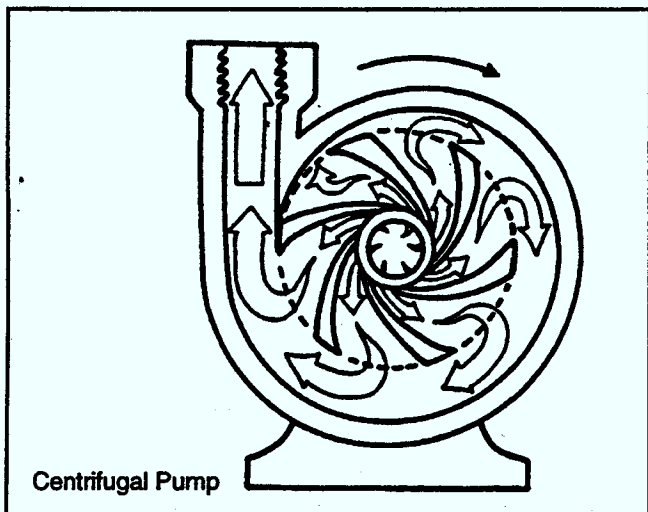
The pump must be adequate for all the spraying pressures you use. It must provide enough flow to supply all nozzles, allow for hydraulic agitation when needed, and leave a reserve to allow for loss of flow due to wear.

Pumps should resist corrosion and abrasion. You will damage a pump if you operate it dry or with a restricted inlet. Follow the manufacturer's recommendation for pump operation. Keep all shields in place.

Centrifugal Pumps

Centrifugal pumps use a high-speed impeller to deliver high volumes at low pressures. Two-stage centrifugal pumps develop pressures in excess of 200 psi. The operating speed is relatively high. Pressure regulators or release valves are not necessary but are desirable. Pressure depends on the rpm's of the impeller.

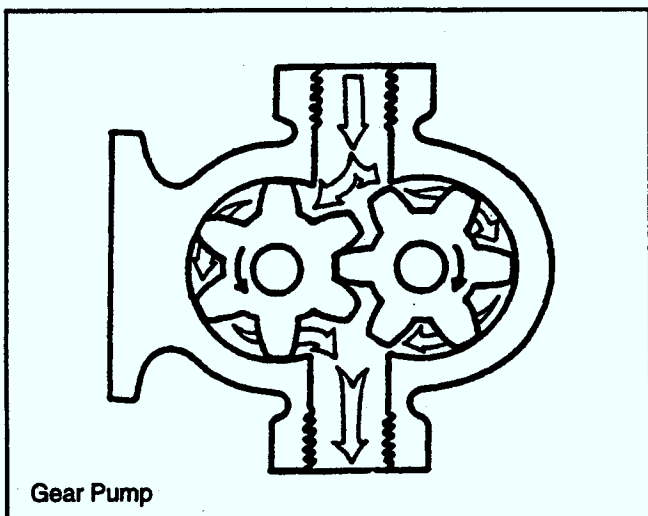
Because the impeller does not contact the pump housing, most centrifugal pumps are satisfactory for pumping abrasive mixtures, such as wettable powder suspensions, even when they are concentrated. Centrifugal pumps are not self-priming, so they must be mounted below the tank outlet, or a separate priming system must be built into the system.



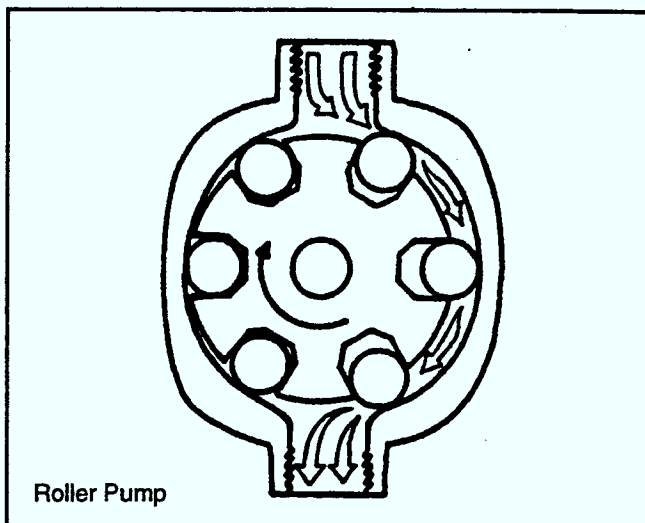
Gear Pumps

Gear pumps are simple, low-priced, positive-displacement pumps that are used for operating pressures of up to 100 pounds. They are satisfactory for pumping liquids or emulsions but wear rapidly if suspensions (wetable powders) are used. They are self-priming when in good condition but may lose that ability when worn. Depending on size, they deliver low to moderate volumes of liquid.

Gear pumps are not affected by solvents since all the



parts are metal. Some are cast iron with stainless steel impellers; others are bronze. They will resist corrosion. Gear pumps are commonly used on most blowers and boom sprayers. When a gear pump becomes worn, it usually cannot be satisfactorily rebuilt.

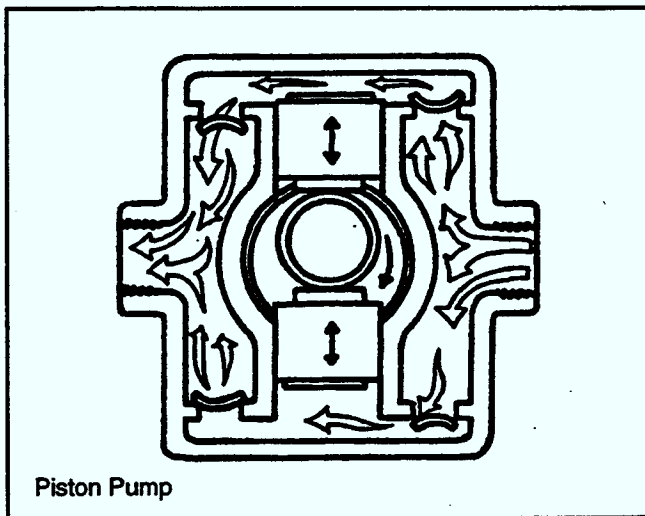


Roller Pumps

Roller pumps are most commonly used on low-pressure sprayers. They are semi-positive displacement, self-priming pumps. The rollers are made of either nylon or of rubber, which is more abrasion-resistant. The rollers can be replaced when worn or swollen. Suspensions will wear both the rollers and the housing relatively quickly.

Diaphragm Pumps

Diaphragm pumps are self-priming and are similar to gear and roller pumps in volume and pressure characteristics. Since the spray mixture does not come in contact with any moving metal parts except the valve assembly, these pumps are abrasion-resistant. The neoprene diaphragm may be damaged by some solvents. When pressure requirements are not high, these pumps are probably the best choice for abrasive spray suspensions.



Piston Pumps

Piston pumps are the most desirable of the commonly used sprayer pumps when high pressures are necessary. Some are designed to operate at sustained pressures of 600 psi or more. They can deliver high volumes of liquid and are self-priming. Most piston pumps have replaceable plunger cups made of leather, neoprene, or nylon fabric that are easily replaced.

Pressure Regulators

The pressure regulator controls the pressure of the spray material delivered by the nozzles. It protects pump seals, hoses, and other sprayer parts from damage due to excessive pressure, and it bypasses excess pump capacity to the tank. When selecting a pressure regulator, be certain that the flow and pressure capacity of the regulator matches that of the pump being used.

Pressure Gauges

These serve as the monitor of your spraying job. They must be accurate and have only the range needed for your work. For example, a 0-60 psi gauge with 2-pound graduations would be sufficient for most low-pressure sprayers.

Check frequently for accuracy against an accurate gauge. Do not use gauges under too much pressure. Keep glass faces clean and intact. Use gauge protectors to protect against corrosive pesticides and pressure surges.

A pressure gauge is essential on any sprayer to tell how the sprayer is functioning. If the pressure does not remain constant, the amount of liquid coming out of the nozzles will vary. The gauge should always be mounted so that the operator can see it easily. Pressure gauges often wear out soon because they become clogged with solid particles of spray material. A glycerine-loaded diaphragm-type is more expensive but will last indefinitely.

Control Valves

These should be large enough so as not to restrict flow. They should be easy for you to reach. On-off action should be quick and positive. You need to be able to cut off all flow or flow to any section of the spraying system. There are many different kinds of control valves. Be sure you know how to operate and maintain the ones on your equipment.

Hoses

There are four main points to consider in selecting sprayer hoses:

- Composition (chief liner material).
- Construction (reinforcement, rigidity, or flexibility).
- Working pressure.
- Size.

High-quality hoses and fittings are expensive, but they are economical when used over a long period of time. Consult manufacturers about the ability of different types of hoses to resist damage from pesticides. The working pressures of the hose should be equal to the maximum pressure the pump delivers. If the hose is too small (inside diameter), the sprayer will not operate properly. If the suc-

tion line hose is too small, there will be a reduction in pressure and a drop in volume. Consult the manufacturer's data for capacities at different levels of pressure.

Select synthetic rubber or plastic hoses that have a burst strength greater than peak operating pressures, that resist oil and solvents present in pesticides, and that are weather-resistant.

Suction hoses should resist collapse. They should be larger than pressure hoses. All fittings on suction lines should be as large or larger than the line itself.

Keep hoses from kinking or being rubbed. Rinse them often, inside and outside, to prolong life. Remove and store hoses during off season, or at least store the unit out of sunlight. Replace hoses at the first sign of surface deterioration.

Nozzles

The nozzle helps control the rate and pattern of distribution. These things depend on the nozzle design or type, its operating pressure, the size of the opening, its discharge angle, and its distance from the target.

A nozzle is an atomizing device that meters and spreads the liquid droplets in a definite spray pattern. A complete assembly consists of (1) body, (2) screen, (3) cap, and (4) tip or orifice plate. Several different nozzle designs are available. All designs perform adequately, but each design has advantages for specific spraying jobs.

The function of the nozzle body is to attach the screen and tip to the boom. There are a variety of replacement nozzle tips or discs to meet different spraying requirements. Manufacturers of sprayer nozzles can supply data sheets for the delivery rate (usually in gallons per minute at different pressures). The application rate *cannot* be specified on these data sheets unless the forward speed of the sprayer and the spraying pressure are specified.

Never operate nozzles at high pressures to compensate for selecting the wrong nozzle size. Unnecessarily high pressures increase both the rate of nozzle wear and the drift hazard.

You can get nozzles in many materials. Here are the main features of each kind.

Brass: Inexpensive; wears quickly from abrasion; probably the best material for limited use.

Stainless steel: Will not corrode; resists abrasion (especially if it is hardened); relatively expensive.

Plastic: Resists corrosion and abrasion; swells when exposed to some solvents.

Aluminum: Resists some corrosive materials; easily corroded by some fertilizers.

Tungsten carbide and ceramic: Highly resistant to abrasion and corrosion; expensive.

Keep nozzles in good working condition. For most boom applications, select nozzles of uniform type and size.

Nozzle caps should not be overtightened. Adjust nozzle distance and spacing to suit the target. Follow the nozzle manufacturer's instructions and the pesticide label. Allow for crop or weed height if necessary. Check each nozzle for uniform flow, using water and a jar marked in ounces. Replace any nozzle whose flow is 5 percent more or less than the average. Replace any nozzles having faulty spray

patterns. A good check is to spray on asphalt pavement. Watch for streaks as the spray dries.

Clean nozzles only with a toothbrush or a wooden toothpick. Never use knives, wire, or other metal objects.

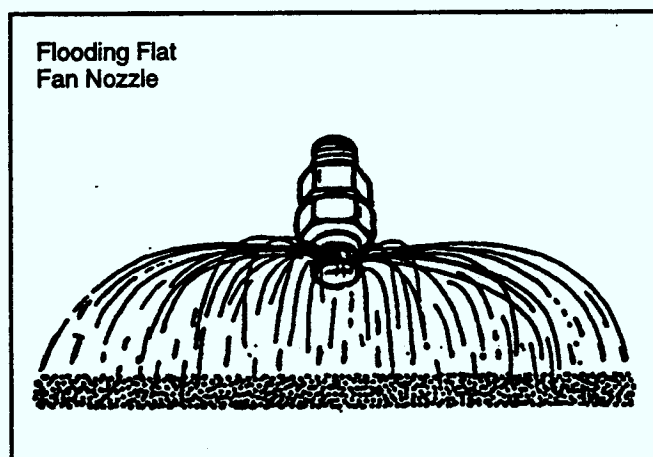
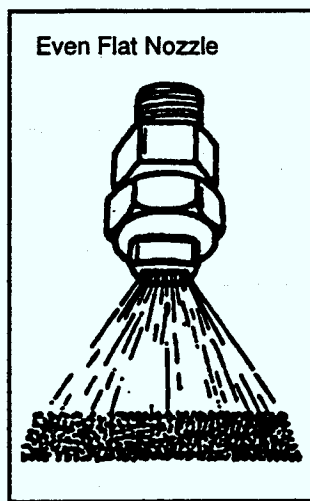
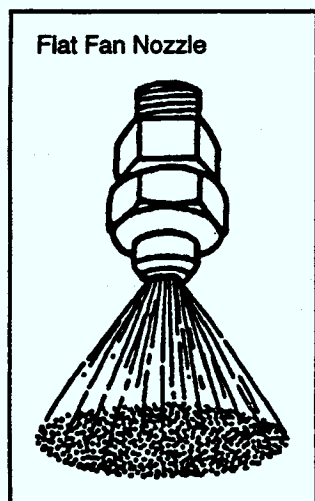
Types Of Nozzles

Nozzles commonly used include (1) flat fan, (2) even flat fan, (3) flooding flat fan, (4) hollow cone, (5) solid cone, (6) atomizing, (7) off-center (OC) or broadcast, and (8) solid stream.

Flat Fan Nozzle

The most commonly used flat-pattern nozzles have a spray angle of 65, 73, or 80 degrees; the most commonly used pressure is 30 psi. For most herbicide spraying done with a relatively short boom (20 to 35 feet), the 80-degree flat-pattern nozzle is best. It is possible to keep the boom low to reduce the drift hazard and give a uniform distribution of spray material over the entire length of the boom.

The *regular flat fan nozzle* is used for broadcast spraying. The pattern is a narrow oval with lighter edges. When a series of these nozzles is properly mounted on a boom and overlapped 30 to 50 percent, the spray material is more evenly distributed along the boom length. Above 40 psi, flat fan nozzles deliver small to medium droplets that may drift excessively.



The *even flat fan nozzle* makes a uniform pattern across its width. It is used for band spraying and for treating walls and other surfaces.

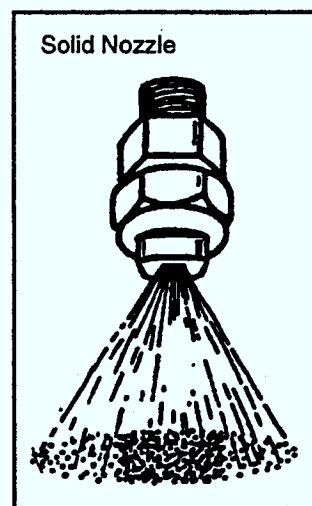
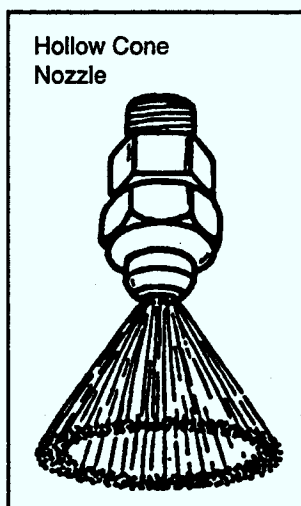
The *flooding flat fan nozzle* makes a wide-angle flat spray pattern. It works at lower pressures than the other flat fan nozzles, so drift hazard is reduced. Its pattern is fairly uniform across its width. It is used for broadcast spraying.

Hollow Cone Nozzle

There are two types of hollow cone nozzles: the core and disk and the whirl chamber. The pattern is circular with little or no spray in the center. It is used for spraying foliage with insecticides and fungicides.

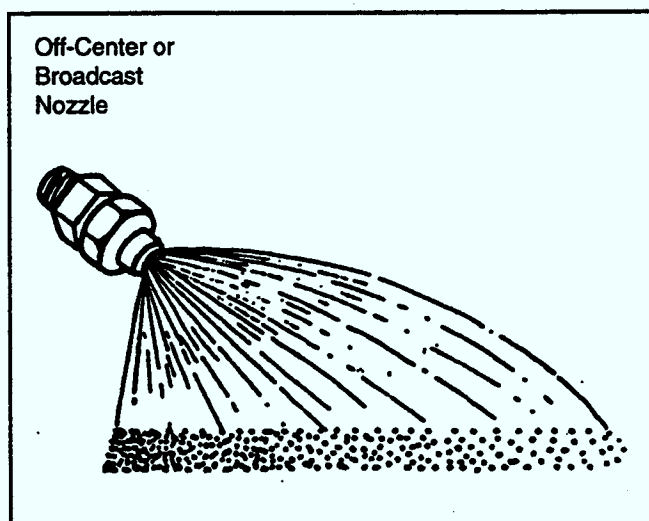
Solid Cone Nozzle

This nozzle produces a circular pattern. The spray is well distributed throughout the pattern. It is used for spraying foliage with insecticides and fungicides.



Off-Center Or Broadcast Nozzle

This nozzle forms a wide flat fan pattern. It is used on boomless sprayers to extend the effective swath width when attached to the end of a boom or on directed spray rigs for row crops.



Solid Stream Nozzle

This nozzle is used in handguns to spray a distant target and for crack and crevice treatment in buildings. It may also be used in a nozzle body to apply pesticides in a narrow band or inject them into the soil.

Many spraying jobs could be done by more than one nozzle type or pattern. Here are some general guidelines.

For Weed Control:	flat fan flooding flat fan even flat fan off-center
For Disease Control:	hollow cone solid cone
For Insect Control:	flat fan hollow cone solid cone solid stream (crack and crevice treatments)

Granular Applicators

Granular pesticides for weed, insect, disease, or nematode control must be applied accurately for effective and safe pest control. They distribute granules in several ways, including pneumatic (air carriers), whirling discs, multiple hole gravity or force-fed spreaders and soil injectors.

Advantages: Relatively inexpensive; simple to use; no mixing required; less hazardous to applicator; minimize drift.

Limitations: Limited use against some pests; poor lateral distribution (especially on side slopes); require extreme care in calibration.

Equipment Maintenance

Always read and follow the operator's manuals for all your spray equipment. They will tell you exactly how to use and care for it. After each use, rinse out the entire system. Remove and clean nozzles, nozzle screens, and strainers. Check for leaks in line, valves, seals, pump, and tank both after filling with water and during running.

Be alert for nozzle clogging and changes in nozzle patterns. If nozzles clog or other trouble occurs while spraying, be careful not to contaminate yourself while correcting the problem. Shut off the sprayer and move it to an untreated area before dismounting. Wear protective clothing while making repairs.

Clean and check the sprayer booms, hoses, and nozzles when there is spray material in the tank. Rather than using contaminated water from the tank, hook a hose to the discharge side of your spray pump and do the cleaning with uncontaminated water from the domestic water supply. This is particularly convenient if the spray tank has spray mix in it. Remember, however, that the first discharge from the nozzles will be spray mix. Remember also that back-siphoning can occur even in pressure water system. A sudden heavy drain on the system will cause a negative pressure and can suck pesticides from a tank back into the water system.

Even repeated flushing with water is not a dependable method to remove some herbicide residues from any spray tank, pump, hose, boom, and bypass system. Emulsifiable formulations such as esters and oil-soluble amines are more difficult to remove than water-soluble metallic and amine salts. Wooden tanks are almost impossible to decontaminate.

If you must decontaminate, circulate a solution of household ammonia or detergent (1 quart to 25 gallons of water, preferably warm) through the sprayer at operating pressure, including hoses, booms, and nozzles. Let stand for several hours, drain, flush, and add more water. Test by spraying a few sensitive plants. Injury will usually appear in 2 to 7 days if the sprayer is still contaminated.

Normally, you will not get inside your spray tank; however, some repairs require you to do so. If so, remember that it is probably a highly toxic area. Avoid working alone. Wear full protective gear to prevent both dermal and inhalation exposure. Even welding outside the tank can generate highly toxic fumes. Use a respirator.

Store sprayers correctly after completing each job. First, rinse and clean the system. Then fill the tank almost full with clean water. Add a small amount of new light oil to the tank. Coat the system by pumping the tank contents out through holes. Drain the pump and plug its openings or fill the pump with light oil or antifreeze. Remove the nozzles and nozzle screens and store them in light oil or diesel fuel.

Equipment Calibration

Calibration is simply adjusting your equipment to apply the desired rate of pesticide. You need to do this so that you can be sure you are using each pesticide as directed on the label. Too much pesticide use is costly, inefficient, and could be dangerous; too little will not do a good job, and uneven application results in spotty control. Only by calibrating correctly can you safely get the best results. Proper adjustment and calibration of the equipment can prevent needless waste of pesticides.

The total deposit applied on the target depends on:

- The concentration of pesticide in the tank.
- The rate of delivery (gallons per minute).
- The speed at which the equipment travels.
- The area covered (the swath width).

All these factors must be known if the desired deposit is to be obtained.

There are many ways to calibrate equipment. The preferred methods differ according to the kind of equipment you use. Equipment instructions will show you how to calibrate your equipment.

Pesticide labels usually give application rates per acre. The following table will help determine the linear distance required to cover one acre.

Linear Distance to Cover One Acre Using Various Swaths

Swath (feet)	Linear Distance to 1 Acre	
	(feet)	(miles)
1	43,560	8.250
2	21,780	4.125
3	14,520	2.750
4	10,890	2.062
5	8,712	1.650
6	7,260	1.375
8	5,445	1.031
10	4,356	0.825
12	3,630	0.687
14	3,111	0.589
16	2,722	0.515
18	2,420	0.458
20	2,178	0.412
25	1,742	0.330
30	1,452	0.275

Calibrating Sprayers

If your sprayer is delivering more or less spray than desired, you can change the rate three ways:

1. Change the pressure. Lower pressure means less spray delivered; higher pressure means more spray delivered. This is not a good method because a pressure change may change the nozzle pattern and droplet size. Changing the pressure changes the output only slightly. The pressure must be increased four times to double the output.

2. Change the speed of your sprayer. Slower speed means more spray delivered, faster speed means less spray delivered. This method is practical for moderate changes in delivery rate. If you drive half as fast, you double the delivery rate.

3. Change the nozzle tips. This is the best method for making major changes in the delivery rate of sprayers. The larger the hole in the tip, the more spray delivered. Always select nozzles for the job you want done. Use the manufacturer's performance charts to make your selection.

After changing one or more of the above variables, you must recalibrate your sprayer to make sure the rate is correct.

Measurement Method

First, choose the speed, pumping pressure, and nozzle or nozzles that you want to use. Fill the spray tank with water and operate the sprayer in place to fill the plumbing. Refill the tank and spray a measured area as if you were applying the pesticide. Measure the amount of water needed to refill your tank. This is the application rate per unit of area. If it takes 20 gallons to refill the tank after spraying one acre, you are spraying at the rate of 20 gallons per acre. You should spray an area large enough to use at least 10 percent of the tank capacity.

Arithmetic Calibration Method

First, determine the pumping rate (gallons per minute or GPM):

1. Fill spray tank and sprayer plumbing completely full of water.

2. Put vehicle in neutral at the throttle setting (rpm) desired.

3. Open the spray valve and pump for a predetermined time.

4. Close valve, shut down the equipment, and remeasure the amount of water needed to refill the tank.

5. Divide the number of gallons needed to refill the tank by the time of pump operation to get the pumping rate—gallons per minute.

EXAMPLE: If it takes 10 gallons to refill your spray tank after operating the pump for 5 minutes, then:

$$\begin{aligned}
 \text{Gallons/minute} &= \frac{\text{gallons to refill tank}}{\text{minutes of pump operation}} \\
 &= \frac{10 \text{ gallons}}{5 \text{ minutes}} \\
 &= 2 \text{ gallons/minute pumping rate}
 \end{aligned}$$

Next, determine the gallons per acre.

1. Determine the number of feet the sprayer moves at the desired speed and throttle.

2. Measure the width of the sprayer boom.

3. Determine the pumping rate—GPM.

4. Calculate the area that the sprayer covered in 1 minute (distance traveled × boom width).

NOTE: One mile per hour equals 88 feet per minute.

Example: Your sprayer which has a 20-foot boom traveled 435 feet in one minute. How many square feet were treated?

$$\begin{aligned}
 \text{Area} &= \text{length (feet)} \times \text{width (feet)} \\
 &= 435 \text{ feet/minute} \times 20 \text{ feet} \\
 &= 8,700 \text{ square feet/minute}
 \end{aligned}$$

Calculate how many minutes is required to treat one acre.

NOTE: One acre equals 43,560 square feet.

$$\begin{aligned}
 \text{Minutes/acre} &= \frac{\text{square feet}}{\text{acre}} \times \frac{\text{minutes}}{\text{square feet}} \\
 &= \frac{43,560 \text{ sq. feet}}{1 \text{ acre}} \times \frac{1 \text{ minute}}{8,700 \text{ sq. feet}} \\
 &= \frac{43,560 \times 1}{1 \times 8,700} \frac{(\text{sq. feet}) (\text{minute})}{(\text{acre}) (\text{sq. feet})} \\
 &= \frac{43,560 \text{ minutes}}{8,700 \text{ acres}} \\
 &= 5 \text{ minutes/acre}
 \end{aligned}$$

Calculate the amount of solution applied per acre (gallons per acre or GPA).

$$\begin{aligned}
 \text{Gallons/acre} &= \frac{\text{gallons}}{\text{minute}} \times \frac{\text{minutes}}{\text{acre}} \\
 &= \frac{2 \text{ gallons}}{1 \text{ minute}} \times \frac{5 \text{ minutes}}{1 \text{ acre}} \\
 &= \frac{2 \times 5}{1 \times 1} \frac{\text{gallons}}{\text{acre}} \\
 &= 10 \text{ gallons/acre}
 \end{aligned}$$

PROBLEM 1—Your sprayer pumps 15 gallons in 5 minutes. You have determined that at the gear and throttle setting you intend to use, your sprayer moves 6 mph. The spray pattern covers a space 15 feet wide.

- What is the pumping rate (gallons per minute)?
- How many square feet does your sprayer cover in 1 minute?

$$\begin{aligned}
 \text{Gallons/minute} &= \frac{\text{gallons}}{\text{minutes}} \\
 &= \frac{15 \text{ gallons}}{5 \text{ minutes}} \\
 &= 3 \text{ gallons/minute}
 \end{aligned}$$

b) Square Feet per Minute

First, determine how far your sprayer will travel in 1 minute.

$$\begin{aligned}
 1 \text{ mph} &= \frac{6 \text{ mph}}{88 \text{ fpm}} \\
 \text{Where: mph} &= \text{miles per hour} \\
 \text{Where: fpm} &= \text{feet per minute} \\
 (1 \text{ mph}) (X \text{ fpm}) &= (6 \text{ mph}) (88 \text{ fpm}) \\
 X \text{ fpm} &= \frac{(6 \text{ mph}) (88 \text{ fpm})}{(1 \text{ mph})} \\
 &= \frac{6 \times 88 (\text{mph}) (\text{fpm})}{1 (\text{mph})} \\
 &= 528 \text{ feet/minute}
 \end{aligned}$$

$$\begin{aligned}
 \text{Sq. ft./minute} &= \text{boom width (ft.)} \times \frac{\text{feet}}{\text{minute}} \\
 &= \frac{15 \text{ feet}}{1} \times \frac{528 \text{ feet}}{\text{minute}} \\
 &= \frac{15 \times 528}{1} \frac{(\text{feet}) (\text{feet})}{\text{minute}} \\
 &= 7,920 \text{ sq. ft./minute}
 \end{aligned}$$

c) Minutes per Acre

$$\begin{aligned}
 \text{Minutes/acre} &= \frac{\text{square feet}}{\text{acre}} \times \frac{\text{minutes}}{\text{square feet}} \\
 &= \frac{43,560 \text{ sq. feet}}{1 \text{ acre}} \times \frac{1 \text{ minute}}{7,920 \text{ sq. feet}} \\
 &= \frac{43,560}{7,920} \frac{(\text{sq. feet}) (\text{minute})}{(\text{acre}) (\text{sq. feet})} \\
 &= 5.5 \text{ minutes/acre}
 \end{aligned}$$

d) Gallons per Acre

$$\begin{aligned}
 \text{Gallons/acre} &= \frac{\text{gallons}}{\text{minute}} \times \frac{\text{minutes}}{\text{acre}} \\
 &= \frac{3 \text{ gallons}}{1 \text{ minute}} \times \frac{5.5 \text{ minutes}}{\text{acre}} \\
 &= \frac{3 \times 5.5}{1 \times 1} \frac{(\text{gallons}) (\text{minutes})}{(\text{minute}) (\text{acre})} \\
 &= 16.5 \text{ gallons/acre}
 \end{aligned}$$

- How many minutes would it take to spray 1 acre?

- How many gallons of solution does your sprayer apply per acre?

a) Gallons per Minute

Amount Of Pesticide Per Tank

You have adjusted your sprayer and you know how many gallons of solution your equipment will apply per acre. Next, you must find out how much pesticide to put in the tank to apply the correct dosage of pesticide. To do this you need to know two more facts:

- How much your sprayer tank holds.
- The amount of formulation to be used per unit of area.

First, determine how many acres you can cover with one tank of solution.

$$\begin{aligned}
 \text{Acres/tank} &= \frac{\text{gallons}}{\text{tank}} \times \frac{\text{acre}}{\text{gallons}} \\
 &= \frac{300 \text{ gallons}}{1 \text{ tank}} \times \frac{1 \text{ acre}}{30 \text{ gallons}} \\
 &= \frac{300 \times 1}{1 \times 30} \frac{(\text{gallons}) (\text{acre})}{(\text{tank}) (\text{gallons})} \\
 &= 10 \text{ acres/tank}
 \end{aligned}$$

Next, determine how much of each pesticide must be added to the tank to achieve the correct dosage.

$$\begin{aligned}
 \text{Pesticide A} &= \frac{\text{acres}}{\text{tank}} \times \frac{\text{quarts}}{\text{tank}} \\
 (\text{quarts/tank}) &= \frac{10 \text{ acres}}{1 \text{ tank}} \times \frac{1 \text{ quart}}{1 \text{ acre}} \\
 &= \frac{10 \times 1}{1 \times 1} \frac{(\text{acres}) (\text{quart})}{(\text{tank}) (\text{acre})} \\
 &= 10 \text{ quarts/tank}
 \end{aligned}$$

$$\begin{aligned}
 \text{Pesticide B} &= \frac{\text{acres}}{\text{tank}} \times \frac{\text{pounds}}{\text{acre}} \\
 (\text{pounds/tank}) &= \frac{10 \text{ acres}}{1 \text{ tank}} \times \frac{5 \text{ pounds}}{1 \text{ acre}} \\
 &= \frac{10 \times 5}{1 \times 1} \frac{(\text{acres}) (\text{pounds})}{(\text{tank}) (\text{acre})} \\
 &= 50 \text{ pounds/tank}
 \end{aligned}$$

$$\begin{aligned}
 \text{Pesticide C} &= \frac{\text{acres}}{\text{tank}} \times \frac{\text{gallons}}{\text{acre}} \\
 (\text{gallons/tank}) &= \frac{10 \text{ acres}}{1 \text{ tank}} \times \frac{1 \text{ gallon}}{1 \text{ acre}} \\
 &= \frac{10 \times 1}{1 \times 1} \frac{(\text{acres}) (\text{gallon})}{(\text{tank}) (\text{acre})} \\
 &= 10 \text{ gallons/tank}
 \end{aligned}$$

PROBLEM 3—The instructions also call for surfactant to be used at ½ percent by volume. How much surfactant should be added?

NOTE: ½ percent equals 0.5% or 0.005.

$$\begin{aligned}
 \text{Surfactant} &= \frac{\text{gallons}}{\text{tank}} \times \text{percentage} \\
 (\text{gallons/tank}) &= \frac{300 \text{ gallons}}{1} \times \frac{.005}{\text{tank}} \\
 &= \frac{300 \times 0.005}{1} \frac{(\text{gallons})}{(\text{tank})} \\
 &= 1.5 \text{ gallons/tank}
 \end{aligned}$$

PROBLEM 4—Suppose the formulation of a pesticide is an 80-percent wettable powder and you want to apply 4 pounds of active ingredient per acre. As in Problem 2 your tank will treat 10 acres. How many pounds of formulation must be added to your tank?

NOTE: a.i. equals active ingredient.

For dry formulations:

$$\begin{aligned}
 \text{Product} &= \text{lb. a.i. desired/A.} \times \frac{100}{\text{percent a.i.}} \\
 (\text{pounds/acre}) &= 4 \text{ lb. a.i./A} \times \frac{100}{80} \\
 &= \frac{4 \times 100}{80} \\
 &= 5 \text{ pounds product/acre}
 \end{aligned}$$

$$\begin{aligned}
 \text{Product} &= \frac{\text{pounds}}{\text{acre}} \times \frac{\text{acres}}{\text{tank}} \\
 (\text{pounds/tank}) &= \frac{5 \text{ pounds}}{1 \text{ acre}} \times \frac{10 \text{ acres}}{1 \text{ tank}} \\
 &= \frac{5 \times 10}{1 \times 1} \frac{(\text{pounds}) (\text{acres})}{(\text{acre}) (\text{tank})} \\
 &= 50 \text{ pounds/tank}
 \end{aligned}$$

PROBLEM 5—Suppose the pesticide formulation is a liquid containing 6 pounds of active ingredient per gallon, and you want to apply 4 pounds of active ingredient per acre. Using the same sprayer characteristics as in Problem 4, how many gallons of the pesticide would you add to the tank?

For liquid formulations:

$$\begin{aligned}
 \text{Product} &= \text{lb. a.i. desired/A} \times \frac{\text{gal. product}}{\text{lb. a.i.}} \\
 (\text{gallons/acre}) &= 4 \text{ lb. a.i./A.} \times \frac{1 \text{ gallon}}{6 \text{ lb. a.i.}} \\
 &= \frac{4 \times 1}{6} \frac{(\text{lb. a.i./A.}) (\text{gallon})}{(\text{lb. a.i.})} \\
 &= 0.67 \text{ gallon product/acre} \\
 \text{Product} &= \frac{\text{gallons}}{\text{acre}} \times \frac{\text{acres}}{\text{tank}} \\
 (\text{gallons/tank}) &= \frac{0.67 \text{ gallon}}{1 \text{ acre}} \times \frac{10 \text{ acres}}{1 \text{ tank}} \\
 &= \frac{0.67 \times 10}{1 \times 1} \frac{(\text{gallon}) (\text{acre})}{(\text{acre}) (\text{tank})} \\
 &= 6.7 \text{ gallons product/tank}
 \end{aligned}$$

PROBLEM 2—Suppose your tank holds 300 gallons of spray solution. The directions say to apply a combination of 1 quart of pesticide A, 5 pounds of pesticide B, and 1 gallon of pesticide C per acre. Your sprayer is applying 30 gallons of solution per acre. How much of each pesticide should you add to the tank?

Calibrating Granular Applicators

The application rate of granules applied depends on the size of the metering opening, speed of the agitator or rotor, travel speed, and the flowability of the granules. Granules flow at different rates, depending on size, density, type of granule, temperature, and humidity.

Individual units should be calibrated independently. Even when all the applicators are set the same, tests have shown that large differences in application rates may occur between the different row units. Only by regularly checking calibration of all units can the correct application rate be maintained. The calibration charts furnished with the application unit should be used only as a guideline for the initial setting of the applicator during calibration.

Calibration begins by determining the correct rate of granules to apply. Recommendations vary according to the amount and type of pesticide being used. Rates are usually expressed as pounds per broadcast area (acre or 1,000 square feet) or as ounces per 1,000-foot row.

Adjusting For Different Concentrations

Since the same pesticides may be available in different concentrations of granules, written recommendations are sometimes given as pounds of active ingredient to apply per acre (lb. a.i./A.). For these recommendations you must first convert the lb. a.i./A. to pounds of product per

$$\begin{aligned}
 \text{Product} &= \text{lb. a.i./A.} \times \frac{100\%}{\% \text{ a.i. in product}} \\
 (\text{pounds/acre}) &= 3 \text{ lb. a.i./A.} \times \frac{100\%}{20\%} \\
 &= \frac{3 \times 100}{20} \frac{(\text{pound a.i./A.}) (\%)}{(\text{a.i.}) (\%)} \\
 &= 15 \text{ pounds/acre}
 \end{aligned}$$

acre (lb./A.) for the granules you have purchased. To do this, read the label to determine the percentage of active ingredient in the granules. Then convert the lb. a.i./A. to lb./A.

EXAMPLE: A recommendation calls for 3 lb. a.i./A. You have purchased a 20 percent granular formulation. How much material should you apply per acre?

Calibrating Your Applicator

Most calibration techniques are based on determining the amount of granules dispensed when treating a known area. The procedure used here is to adjust the applicator

$$\text{oz. required} = \frac{\text{lb./A.} \times \text{area treated (sq. ft.)}}{2,722}$$

setting until you collect the required amount of granules while traveling a measured distance or treating a measured area.

STEP 1. Determine the number of ounces required for application over a known distance. For both broadcast and band applications, calculate the number of ounces required to be distributed over a measured course with the following equation:

Area treated is the area actually covered with granules and is the length of a measured course in feet times the width of spread in feet. For broadcast applications, measure the effective swath width; for band applications, measure the band width.

STEP 2: Adjust the initial setting on each applicator according to the equipment manufacturer's recommendation.

STEP 3. Attach a container (plastic bag or plastic jar) over the outlet of the applicator and collect the granules while operating over the measured distance at the speed you plan to apply. Make the calibration run in the actual field to be treated so that speed and traction conditions will be constant.

STEP 4. Weigh the collected granules. Subtract the weight of the container. Since the amount collected may only be a few ounces or grams, the granules should be weighed on a postal scale, baby scale, or food scale. Volume measurements may be inaccurate because of nonuniform settling or segregation of granules. If the amount collected is not equal to the ounces required (Step 1), adjust the gate setting. Then repeat the calibration until you collect the required amount. Do this for all units on a row type applicator.

After you have calibrated the applicator to apply the proper amount of granules, make periodic field checks to verify that the application rate does not change from one day to the next or from one field to another.

There are several ways to field check. One simple method is to place a strip of masking tape vertically on the inside of the application hopper. Then fill the hopper in increments of 1 or 2 pounds. After each increment is added, shake the hopper to settle material and mark the tape at the level of the chemical. Throughout the season, the application rate can be verified by simply reading the level of chemical before and after treating a known number of acres.

Chapter 9

Test

1. List factors to consider in choosing the equipment for applying a pesticide.

- _____
- _____
- _____
- _____

2. List the factors a pesticide applicator must consider to carefully control the amount of pesticide deposited on the target.

- _____
- _____
- _____
- _____

3. List some components of ground spray application equipment.

- _____
- _____
- _____
- _____
- _____
- _____

4. Match the types of nozzles on the right to the correct description.

- ___ a. Solid circular pattern; used for spraying foliage.
- ___ b. Wide flat fan patterns; used on boomless sprayers or directed spray rigs.
- ___ c. Uniform pattern across its width; used for band spraying.
- ___ d. Circular pattern with little or no spray in the center; used for spraying foliage.
- ___ e. Wide angle spray pattern; used for broadcast spraying.
- ___ f. Narrow oval pattern with lighter edges; used for broadcast spraying.
- ___ g. Compact jet used in handguns to spray a distant target or fixed to apply a narrow band or to inject into the soil.

1. Off-center
2. Flooding flat fan
3. Hollow cone
4. Solid cone (full)
5. Solid stream
6. Flat fan
7. Even flat fan

5. List one advantage and one disadvantage for these nozzle materials:

	Advantages	Disadvantages
a. Brass	_____	_____
b. Stainless steel	_____	_____
c. Plastic	_____	_____
d. Aluminum	_____	_____
e. Tungsten carbide and ceramic	_____	_____

6. Name three variables that you can adjust to alter the delivery rate of a sprayer.

- _____
- _____
- _____

7. Assume your sprayer has a 200-gallon tank and you apply 20 gallons per acre. How much chemical do you add per tankful to apply 3 pounds per acre?

Answer: _____

8. Using the following facts, determine the pumping rates, speed the sprayer travels per minute, time to cover 1 acre, and amount of solution applied per acre.

Facts:

10 gallons of spray in 5 minutes
Spray boom width = 25 feet
Sprayer moves at 5 miles per hour
One mph = 88 feet per minute
One acre = 43,560 square feet

Answers:

- a. Pumping rate _____
- b. Distance sprayer travels per minute _____
- c. Time to cover 1 acre _____
- d. Amount of solution applied per acre _____

9. Solve the following problems:

Your tank holds 100 gallons of spray solution. The directions say to apply a combination of 1 quart of pesticide X, 5 pounds of pesticide Y, and 1 gallon of pesticide Z per acre. Your sprayer will apply 10 gallons of this total solution per acre.

- a. How many acres will one tank load spray? _____
- b. How much of each pesticide should be added to the tank to achieve the proper dosage?
 - Pesticide X _____
 - Pesticide Y _____
 - Pesticide Z _____
- c. The instructions also call for surfactant to be used at $\frac{1}{2}$ percent by volume. How much surfactant should be added to the tank?

10. The broadcast application of an insecticide granule is to be made at 3 lb/A. The effective swath width of the application equipment is 60 inches (5 feet). A 500-foot distance is used for calibration. How many ounces should be collected?

Answer: _____

Test Answers

Chapter 1. Pests

1.
 - a. Pests—living things that compete with human beings for food, fiber, and space or attack humans directly.
 - b. Hosts—living plants or animals some pests depend on for survival.
2.
 - a. Insects—plus mites, ticks, and spiders
 - b. Snails and slugs
 - c. Vertebrates
 - d. Weeds
 - e. Plant disease agents
3.
 - a. Six jointed legs
 - b. Three body regions
4.
 - a. Wings
 - b. Mouthparts
5.
 - a. Some change only in size as they develop.
 - b. Some change form slightly.
 - c. Some change completely in form and size.
6.
 - a. Eight jointed legs
 - b. Two body regions
 - c. Lack wings
7.
 - a. Fish
 - b. Reptiles
 - c. Amphibians
 - d. Birds
8.
 - a. Fungi
 - b. Bacteria
 - c. Viruses
 - d. Nematodes
9.
 - a. Overdevelopment of tissue
 - b. Underdevelopment of tissue
 - c. Death of tissue
10. Weeds are plants growing where they are not wanted or in a way that is not desirable.
11. Herbaceous grasses:
 - a. One leaf as they emerge.
 - b. Leaves narrow and upright; veins parallel.
 - c. Fibrous root system.
 - d. Growing point sheathed and under soil surface.
 - e. Growing point gradually moves above soil as plant matures.Herbaceous broadleaves:
 - a. Two leaves as they emerge.
 - b. Leaves broad with net-like veins.
 - c. Exposed growing points at end of each stem.
 - d. Perennial broadleaved plant may have growing points on roots and stems below soil.Woody plants—those which form wood, including:
 - a. Brush and shrubs having several stems and less than 10 feet tall.
 - b. Trees—single stem and greater than 10 feet tall.

12. a. Seedling—small with seed leaves present.
b. Vegetative—rapid growth of stems, roots, and foliage. Water and nutrient uptake rapid.
c. Seed production—little or no growth; produces fruit. Water and nutrient uptake and movement slow and directed to reproductive parts (flower, fruit, seeds).
d. Maturity—little or no growth. Movement of water and nutrients slow.
13. Annuals—complete life cycle in less than 12 months.
Biennials—complete life cycle in 2 years.
Perennials—live more than 2 years; may live indefinitely.
14. a. A
b. B
c. A
d. P
e. P

Chapter 2. Pest Control And Pesticides

1. a. Resistant varieties
b. Biological control
c. Cultural control
d. Mechanical-physical control
e. Sanitation
f. Legal control
g. Pesticides
2. a. Prevention
b. Suppression
c. Eradication
3. a. 18 e. 8 i. 2 m. 13 q. 16
b. 17 f. 6 j. 1 n. 12 r. 15
c. 3 g. 4 k. 10 o. 11
d. 5 h. 7 l. 9 p. 14
4. a. 11 e. 9 i. 3
b. 4 f. 10 j. 8
c. 6 g. 1 k. 7
d. 5 h. 2
5. Preplant—applied before crop is seeded.
Preemergence—applied before crop or weeds emerge.
Postemergence—applied after crop or weeds have emerged.
6. a. Effectiveness against the pest.
b. Plant, animal, or surface to be protected.
c. Application machinery available.
d. Danger of drift and runoff.
e. Cost of application.
f. Hazards to applicator or to other persons, plants, and animals.
7. a. 9 e. 11 i. 5
b. 1 f. 3 j. 7
c. 10 g. 8 k. 6
d. 2 h. 4

8.	ADVANTAGES	DISADVANTAGES
Granules	Ready to use; easy to apply; can be applied to target under dense foliage	Limited foliage use; expensive
Emulsifiable concentrate	High concentration; relatively inexpensive; suitable for low-pressure equipment with limited agitation	Volatility potential; may be hazardous to applicator; phytotoxicity
Wettable powder	Relatively inexpensive; safer than emulsifiable concentrate to use on tender foliage; easy to measure	May be hazardous to applicator; requires mechanical agitation; difficult to mix; may clog nozzles

- | | | |
|---------|-------|------|
| 9. a. 3 | e. 5 | i. 1 |
| b. 12 | f. 10 | j. 8 |
| c. 4 | g. 6 | k. 2 |
| d. 11 | h. 9 | l. 7 |

Chapter 3. Labels And Labeling

1. a. 3
b. 2
c. 1
d. 4
2. a. 1 e. 5
b. 2 f. 3
c. 4
d. 5,3
3. c
4. a. 2
b. 3
c. 1
5. a. Hazard of poisoning
b. Way pesticide used
c. Effects on environment
6. a. Before purchasing
b. Before preparation (mixing) for use
c. Before applying
d. Before storing or disposing
7. b

Chapter 4. The Environment

1. a. 4
b. 2
c. 1
d. 5
e. 3
2. a. drift
b. runoff
c. leaching
d. crop or livestock residue
e. vaporization
3. a. Spray at low pressure.
b. Use largest practical nozzle openings.
c. Use spray additives.
d. Spray when winds are calm.
4. a. Apply pesticides in the very late afternoon or night
b. Avoid applying pesticides when weeds or crops are in bloom.
c. Use pesticides with short residual action.
d. Avoid formulations that are particularly hazardous to bees (microencapsulated and dusts)
e. Communicate with area beekeepers before making an application.
5. a, c, d
6. a, b, c, d, e

Chapter 5. Applicator Safety

1. a. A
b. C
2. a. Orally
b. Dermally
c. By inhalation
3. a. Toxicity of the pesticide.
b. Formulation of pesticide.
c. Application equipment.
d. Degree of exposure.
4. a. Work in a well ventilated area.
b. Do not work alone.
c. Wear protective clothing.
5. a. Wear protective clothing.
b. Check application equipment for leaks.
c. Never eat, drink, or smoke during application.
d. Proceed in a direction into the wind to prevent working in drift.
6. a. Clean, dry, and store protective equipment.
b. Take a shower at the end of each day.
c. Change work clothing daily.
d. Wash work clothes separate from family wash.
7. a. Choose coveralls made of a closely woven fabric.
b. Coveralls should cover entire body from wrist to ankles.
c. Wear pants legs outside of boots.
d. Do not allow coveralls to become soaked with spray.
8. a. Check the pesticide label for the best glove material.
b. Check gloves for holes.
c. Wear sleeves outside gloves.
d. Wash gloves before taking them off.
9. a. Wear lightweight, unlined neoprene or natural rubber boots.
b. Wash boots often, allow to thoroughly dry.
c. Keep an extra pair of boots on hand.
d. Wear pants legs outside boots.
10. a. Make sure goggles or face shield fits tightly.
b. Clean them after each use.
c. Change headbands often if cloth or leather.
d. Always wear when pouring or mixing concentrates.
11. a. Use widebrimmed waterproof head coverings.
b. Do not use cloth on leather headbands.
12. a. 3 e. 2 i. 4
b. 7 f. 8
c. 1 g. 9
d. 6 h. 5
13. Irritation of the mouth and throat, vomiting, chest and abdominal pain, diarrhea, skin and eye irritation, coughing, dizziness, nosebleed.
14. a. 8 e. 11 i. 2 m. 6
b. 5 f. 4 j. 10
c. 9 g. 12 k. 1
d. 7 h. 3 l. 13

15. a. Wash off pesticide, remove contaminated clothing, clean skin, keep victim warm.
 - b. Wash with large amounts of water, remove contaminated clothing, cover area loosely with clean soft cover, do not apply ointment, grease, powder, or other agents.
 - c. Wash as quickly and gently as possible with plain water.
 - d. Carry victim to fresh air; ventilate area if in enclosed space; protect yourself.
16. b

Chapter 6. Laws And Regulations

1. Federal Insecticide, Fungicide, and Rodenticide Act
2. Any five of the following:
 - a. Extends federal regulations to cover all pesticides used in the United States instead of only those shipped across state lines.
 - b. Requires registration of pesticides with EPA.
 - c. Makes misuse unlawful.
 - d. Gives EPA authority to classify pesticides as "general" or "restricted".
 - e. Requires certification of applicators using "restricted use" pesticides.
 - f. Sets minimum standards for determining competency of applicators.
 - g. Provides stronger enforcement provisions and establishes penalties for violation of FIFRA.
3. When you haul pesticides between states and someone is killed, someone is hospitalized, or damages exceed \$50,000.
4. a. T d. F
b. F e. T
c. T
5. The Environmental Protection Agency.
6. 24(c) refers to section 24(c) of FIFRA which allows states to register federally registered pesticides for specific uses that are not listed on the federal label. These registrations are also known as Special Local Need (SLN) registrations.
7. The Alabama Department of Agriculture and Industries.
8. Section 18 refers to section 18 of FIFRA which allows the immediate registration of pesticides to deal with emergency pest situations.

Chapter 7. Pesticide Disposal And Storage

1. a. Be sure pesticide is registered for intended use before purchase.
- b. Buy only what is needed.
- c. Avoid mixing until job amount is estimated.
- d. Mix only enough for the job.
2. a. Empty container into tank, drain for 30 seconds.
- b. Fill container one-fifth to one-fourth full of diluent.
- c. Replace cap and rotate to rinse all sides.
- d. Drain rinse into tank for 30 seconds.
- e. Repeat rinse-and-drain two more times.
3. a. Incineration
- b. Burial
- c. Chemical degradation
4. a. Not in a flood plain area.
- b. Downwind or downhill from sensitive areas.
- c. Isolated.
- d. No chance of surface or underground water contamination.
5. Any five of the following:
 - a. Cool, dry, well ventilated.
 - b. Secure (lockable or fenced).

- c. Well drained to collect runoff water.
 - d. Detergent, cleaner, and water available.
 - e. Absorbents available.
 - f. Neutralizers available.
 - g. Cleanup tools available.
 - h. Fire extinguisher present.
6. Any five of the following:
- a. Use only for pesticides.
 - b. Avoid hot places.
 - c. Designate special areas for each pesticide type.
 - d. Keep labels in view.
 - e. Store off floor.
 - f. Store rigid containers upright.
 - g. Store in neat rows with walkways.
7. Any three of the following:
- a. Do not allow children, pets, or uninformed person in the storage area.
 - b. Use protective clothing if label requires.
 - c. Do not handle containers roughly.
 - d. Check containers for leaks.
8. a. Keep people away from area.
- b. Give first aid if someone is contaminated.
 - c. Use an absorbent material to soak up spill.
 - d. Shovel material into leak-proof container.
 - e. Dispose of as you would excess pesticide.
 - f. Do not hose down area.
 - g. Neutralize chemical action (use bleach or lye).
9. a. Isolate spill area.
- b. Confine spill.
 - c. Call manufacturer for help.
 - d. Call Pesticide Safety Team Network.
 - e. Notify authorities (state, county, city).

Chapter 8. Record Keeping

1. Any four of the following:
- a. Required by law.
 - b. Establish proof of proper use.
 - c. Help in problem identification.
 - d. Provide information to trace residue/damage problems.
 - e. Save money (compare chemical performance).
 - f. Improve pest control practice and efficiency.
2. a. Time and date of application.
- b. Target.
 - c. Equipment used.
 - d. Pesticide used.

Chapter 9. Ground Application Equipment And Equipment Calibration

1. a. Target pest.
- b. Site of application.
 - c. Size of the job.
 - d. Formulation used.
2. a. Concentration of pesticide in the tank.
- b. Rate of delivery.
 - c. Speed.
 - d. Area covered (swath width).

3. a. Tank e. Pressure regulator and gauges
b. Agitator f. Control valves
c. Strainer g. Hoses
d. Pump h. Nozzles
4. a. 4 e. 2
b. 1 f. 6
c. 7 g. 5
d. 3

5. ADVANTAGES

- a. Inexpensive.
- b. Will not corrode, resists abrasion.
- c. Resists corrosion and abrasion.
- d. Resists some corrosive materials.
- e. Highly resistant to corrosion and abrasion.

DISADVANTAGES

- a. Wears quickly from abrasion.
- b. Relatively expensive.
- c. Swells with some solvents.
- d. Corroded by some fertilizers.
- e. Expensive.

6. a. Change pressure.
- b. Change speed.
- c. Change nozzle tips.

7. $\frac{200 \text{ gal./tank}}{20 \text{ gal./acre}} = 10 \text{ acres/tank}$

$10 \text{ acres/tank} \times 3 \text{ pounds/acre} = 30 \text{ pounds/tank}$

8. a. $\frac{10 \text{ gal.}}{5 \text{ min.}} = 2 \text{ gal./min.}$

b. $88 \text{ ft./min.} \times 5 \text{ mph} = 440 \text{ ft./min.}$

c. $440 \text{ linear ft./min.} \times 25 \text{ ft. (swath width)} = 11,000 \text{ sq. ft./min.}$

$43,560 \text{ sq. ft./acre} \div 11,000 \text{ sq. ft./min.} = 3.96 (4) \text{ min./acre}$

d. $2 \text{ gal./min.} \times 4 \text{ min./acre} = 8 \text{ gal./acre}$

9. a. $\frac{100 \text{ gal./tank}}{10 \text{ gal./acre}} = 10 \text{ acres/tank}$

b. $10 \text{ acres/tank} \times 1 \text{ qt. X/acre} = 10 \text{ qt. (or 2.5 gal.) X/tank}$

$10 \text{ acres/tank} \times 5 \text{ lb. Y/acre} = 50 \text{ lb. Y/tank}$

$10 \text{ acres/tank} \times 1 \text{ gal. Z/acre} = 10 \text{ gal. Z/tank}$

c. $1/2\% = .005$

$100 \text{ gal.} \times .005 = .5 \text{ gal.}$

10. $500 \text{ ft.} \times 5 \text{ ft.} = 2,500 \text{ sq. ft.}$

$\frac{3 \text{ lb./acre} \times 2,500 \text{ sq. ft.}}{2,722} = \frac{7,500}{2,722} = 2.75 \text{ ounces}$